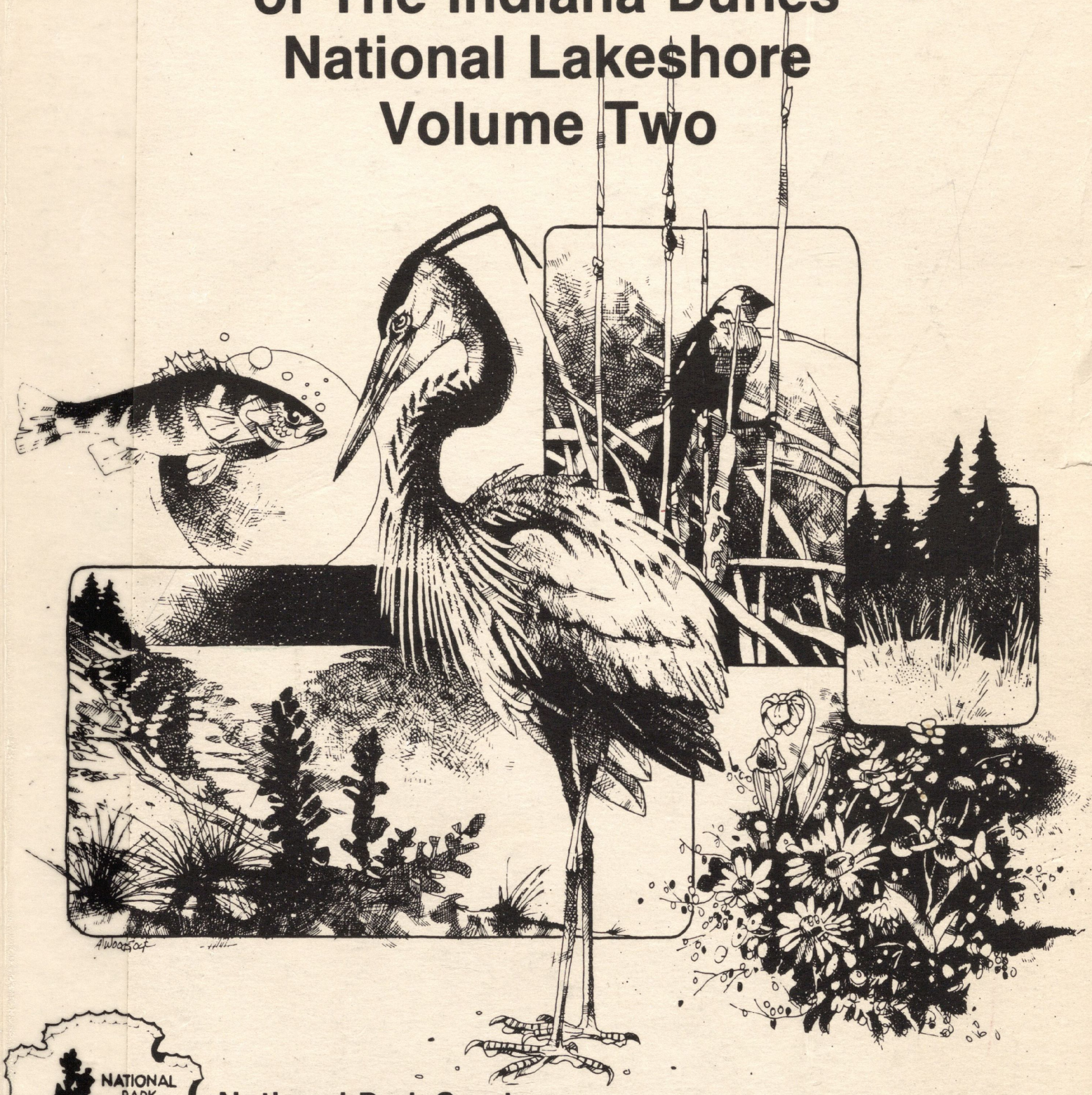
Ecosystem Study of The Indiana Dunes National Lakeshore Volume Two



National Park Service
Midwest Region

Indiana Dunes National Lakeshore
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CHAPTER 3

THE BIOTA OF THE INDIANA DUNES NATIONAL LAKESHORE

by

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Table of Contents

	Page
Table of Contents	3- 1
List of Tables	3- 2
List of Figures	3- 19
Biological Studies in the Indiana Dunes	3- 20
Baseline Study Techniques	3- 23
Terrestrial and Wetland Communities	3- 24
Aquatic Communities	3- 28
Communities of the National Lakeshore	3- 29
Terrestrial Communities	3- 29
Open Beach	3- 29
Foredunes	3- 30
Blowout complexes	3- 58
Dune-shaping processes	3- 67
Pine dunes	3- 73
Black oak forests on relatively young substrates	3- 73
Forests on Glenwood and Calumet shorelines	3-133
Forests on other than sandy substrates	3-150
Hoosier Prairie	3-177
Aquatic Communities	3-193
West Unit intradunal ponds	3-202
West Unit interdunal ponds	3-226
Cowles Unit interdunal ponds	3-226
Morainal pond	3-238
Little Calumet River	3-238
Wetland Communities	3-241
Marshes	3-242
Swamp forests	3-257
Bogs	3-284
Vertebrate Animals of the National Lakeshore	3-310
Amphibians and reptiles	3-311
Birds	3-315
Mammals	3-346
Bibliography	3-351

List of Tables

Table		Page
Table 3- 1	A description of the ranks in the stratum ranking technique; from Lindsey et al. (1961, 1969).	3-27
Table 3- 2	Stratum ranks of herbaceous vegetation on open beach West Beach area--center of E½ SE¼, section 27, T 37 N, R 7 W, West Unit.	3-29
Table 3- 3	A list of beetles common on Indiana beaches of Lake Michigan in late May and early June. Unpublished data provided by coutesy of N.M. Downie.	3-31
Table 3- 4	A list of beetles common on Indiana beaches of Lake Michigan between mid-July and the end of August. Unpublished data provided by courtesy of N.M. Downie.	3-32
Table 3- 5	A list of plants found at a seep along the beach near Crescent Dune--SW¼ NW¼ SE¼, section 30, T 38 N, R 4 W, East Unit.	3-33
Table 3- 6	Stratum ranking of vegetation of stable foredune ridge east of United States Steel jetty--SW¼ NW¼ NE¼, section 36, T 37 N, R 8 W, West Unit.	3-35
Table 3- 7	Stratum ranks of vegetation of old foredune complex behind stable foredune ridge east of United States Steel jetty--SE¼ NE¼ NE¼, section 36, T 37 N, R 8 W, West Unit.	3-36
Table 3- 8	Stratum ranks of vegetation of a partially stabilized foredune in West Beach area--center of E½ SE¼, section 27, T 37 N, R 7 W, West Unit.	3-38
Table 3- 9	Stratum ranks of vegetation of stable foredune in West Beach area--center of E½ SE¼, section 27, T 37 N, R 7 W, West Unit.	3-38
Table 3-10	Stratum ranks of vegetatoin of a partially stabilized foredune just east of Ogden Dunes--SW¼ SE¼ NW¼, section 25, T 37 N, R 7 W, West Unit.	3-38
Table 3-11	Stratum ranks of vegetation of stable foredune complex just east of Ogden Dunes--SW¼ SW¼ NW¼, section 25, T 37 N, R 7 W, West Unit.	3-40
Table 3-12	Stratum ranks of vegetation of stable foredune east of Bailly generating station--NE¼ SE¼ NW¼, section 21, T 37 N, R 6 W, Cowles Unit.	3-40

Table		Page
Table 3-13A	Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from young foredune east of Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980), Cowles Unit.	3-41
Table 3-13B	Invertebrates collected in four of six sample years from young foredune by Texas Instruments, Cowles Unit.	3-47
Table 3-13C	Trophic levels of invertebrates collected in four of six sample years from young foredune, Cowles Unit.	3-47
Table 3-14A	Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from old foredune east of Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980), Cowles Unit.	3-48
Table 3-14B	Invertebrates collected in four of six sample years from old foredune by Texas Instruments, Cowles Unit.	3-55
Table 3-14C	Trophic levels of invertebrates collected in four of six sample years from old foredune, Cowles Unit.	3-56
Table 3- 15	Stratum ranks of plant species on dune adjoining Mount Baldy to the west--NE¼ NE¼ NE¼, section 36, T 38 N, R 5 W, East Unit.	3-60
Table 3- 16	Stratum ranks of vegetation of Crescent Dune--SE¼ NW¼ SE¼, section 30, T 38 N, R 4 W, East Unit.	3-61
Table 3- 17	Stratum ranking of plant species on blowout complex west of Central Avenue--NE¼ NE¼ SE¼, section 35, T 38 N, R 5 W, East Unit.	3-63
Table 3- 18	Stratum ranking of plant species on blowout east of Kemil Raod--NW¼ NW¼ NW¼, section 9, T 37 N, R 5 W, East Unit.	3-64
Table 3- 19	Stratum ranks of vegetation on blowout just west of Dune Acres--centered at eastern margin of SE¼ NE¼ NE¼, section 21, T 37 N, R 6 W, Cowles Unit.	3-65
Table 3- 20	Stratum ranks of vegetation of panne just east of Ogden Dunes--at center of N margin NW¼ NW¼ SW¼, section 25, T 37 N, R 7 W, West Unit.	3-65
Table 3- 21	Stratum ranks of vegetation on blowout lobes just east of Ogden Dunes--center of N half NW¼ SW¼, section 25, T 37 N, R 7 W, West Unit.	3-66
Table 3-22	Stratum ranks of vegetation on stabilized blowout complex in West Beach area--SW¼ SE¼ SE¼, section 27, T 37 N, R 7 W, West Unit.	3-68

Table		Page
Table 3- 23	Stratum ranks of vegetation of mature stand on stabilized blowout complex in West Beach area--SE¼ SE¼ SE¼, section 27, T 37 N, R 7 W, West Unit.	3-69
Table 3- 24	Stratum ranks of plant species of northern third of sandmined portion of West Beach area--NE¼ NW¼ NE¼, section 34, T 37 N, R 7 W, West Unit.	3-70
Table 3- 25	Stratum ranking of plant species on blowout complex east of United States Steel--center of N margin of NW¼ NW¼, section 31, T 37 N, R 7 W, West Unit.	3-71
Table 3- 26	Stratum ranks of vegetation of pine dune east of Bailly generating station--SW¼ SE¼ NW¼, section 21, T 37 N, R 6 W, Cowles Unit.	3-74
Table 3- 27	Stratum ranks of plant species along western margin of blowout just west of Dune Acres--SE¼ NE¼ NE¼, section 21, T 37 N, R 6 W, Cowles Unit.	3-75
Table 3- 28	Stratum ranks of vegetation of pine dune east of Ogden Dunes--SE¼ NW¼ SW¼, section 25, T 37 N, R 7 W, West Unit.	3-75
Table 3- 29	Stratum ranks of plant species of a forest stand along the margin of the West Beach blowout complex--NE¼ NE¼ NE¼, section 34, T 37 N, R 7 W, West Unit.	3-76
Table 3- 30	Stratum ranking of vegetation of Miller Woods upland--NW¼ NE¼ SW¼, section 31, T 37 N, R 7 W, West Unit.	3-78
Table 3- 31	Stratum ranks of vegetation on dune in corridor extending eastward from Miller Woods--SW¼ NE¼ NW¼, section 5, T 36 N, R 7 W, West Unit.	3-81
Table 3- 32	Stratum ranks of vegetation of savannah type community west of County Line Road and north of Amtrak tracks--center of SW¼ SE¼, section 33, T 37 N, R 7 W, West Unit.	3-84
Table 3- 33	Stratum ranks of vegetation of forest stand on dune ridge southeast of Long Lake--center of E½, section 34, T 37 N, R 7 W, West Unit.	3-87
Table 3 -34	Stratum ranks of vegetation of forest stand on dune ridge northwest of Long Lake--NE¼ NW¼ SW¼, section 34, T 37 N, R 7 W, West Unit.	3-89

Table		Page
Table 3- 35	Stratum ranks of vegetation of forest stand with mesophytic pocket north of Long Lake--at center of E½ NE¼ NW¼, section 34, T 37 N, R 7 W, West Unit.	3- 92
Table 3- 36	Stratum ranks of vegetation of forest stand on dunes south of U.S. 12 and west of County Line Road--SE¼ SE¼ NE¼, section 5, T 36 N, R 7 W, West Unit.	3- 93
Table 3- 37	Stratum ranks of vegetation in low lying areas between dunes south of U.S. 12 and west of County Line Road--SE¼ SE¼ NE¼, section 5, T 36 N, R 7 W, West Unit.	3- 96
Table 3- 38	Stratum ranks of vegetation of forest stand on dune complex south of U.S. 12 and east of County Line Road--center of S½ SE¼, section 34, T 37 N, R 7 W, West Unit.	3- 97
Table 3- 39	Stratum ranks of vegetation of forest stand on dune complex east of Ogden Dunes--center of SW¼ SW¼, section 25, T 37 N, R 7 W, West Unit.	3-100
Table 3- 40	Stratum ranking of plant species of forest between Bailly generating station and Mineral Springs Road at Dune Acres--at center of E½, section 21, T 37 N, R 6 W, Cowles Unit.	3-101
Table 3- 41	Stratum ranking of vegetation of forest stand in low area immediately west of Mineral Springs Road at Dune Acres--NE¼ SE¼ NE¼, section 22, T 37 N, R 6 W, Cowles Unit.	3-105
Table 3- 42	Stratum ranking of plant species on slopes bordering Great Marsh to the north--NW¼ SE¼ NW¼, section 23, T 37 N, R 6 W, Cowles Unit.	3-106
Table 3- 43	Stratum ranks of vegetation in portion of forest near marshy areas east of Mineral Springs Road at Dune Acres--at center of NW¼, section 23, T 37 N, R 6 W, Cowles Unit.	3-109
Table 3- 44	Stratum ranks of plant species of prairie openings beyond Lupine Lane and Pine Lane in Dune Acres--NW¼ NE¼ NW¼, section 23, T 37 N, R 6 W and SE¼ SW¼ SE¼, section 14, T 37 N, R 6 W, Cowles Unit.	3-110
Table 3 -45	Stratum ranks of plant species of forest west of Mount Baldy--SE¼ NE¼ NE¼, section 36, T 38 N, R 5 W, East Unit.	3-113
Table 3-46A	Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from immature black oak forest east of Bailly generating station--SW¼ SE¼ NW¼, section 21, T 37 N, R 6 W. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980), Cowles Unit.	3-115

Table		Page
Table 3-46B	Invertebrates collected in four of six sample years from immature black oak forest east of Bailly generating station, Cowles Unit.	3-119
Table 3-46C	Trophic levels of invertebrates collected in four of six sample years from immature black oak forest east of Bailly generating station, Cowles Unit.	3-120
Table 3-47A	Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from mature black oak forest west of Cowles Bog--center of W margin of NW¼ SE¼, section 22, T 37 N, R 6 W. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980), Cowles Unit.	3-121
Table 3-47B	Invertebrates collected in four of six sample years from mature black oak forest northwest of Cowles Bog, Cowles Unit.	3-126
Table 3-47C	Trophic levels of invertebrates collected in four of six sample years from mature black oak forest northwest of Cowles Bog, Cowles Unit.	3-127
Table 3-48A	Invertebrates taken in samples collected July 24, 1980, from open-canopied black oak forest south of U.S. 12 and east of County Line Road--center of S½ SE¼, section 34, T 37 N, R 7 W, West Unit.	3-128
Table 3-48B	Invertebrates taken in abundance from open-canopied black oak forest south of U.S. 12 and east of County Line Road, West Unit.	3-130
Table 3-48C	Trophic levels of invertebrates collected in abundance from open-canopied black oak forest south of U.S. 12 and east of County Line Road, West Unit.	3-130
Table 3-49A	Invertebrates taken in samples collected July 24, 1980, from mesophytic pocket of black oak forest northwest of Long Lake--E½ NE¼ NW¼, section 34, T 37 N, R 7 W, West Unit.	3-131
Table 3-49B	Invertebrates taken in abundance from mesophytic pocket of black oak forest northwest of Long Lake, West Unit.	3-134
Table 3-49C	Trophic levels of invertebrates collected in abundance from mesophytic pocket of black oak forest northwest of Long Lake, West Unit.	3-134

Table		Page
Table 3- 50	Stratum ranking of plant species of forest on Calumet beach ridge west of Kemil Road--SE¼ SW¼ NE¼, section 17, T 37 N, R 5 W, Tremont Unit.	3-136
Table 3- 51	Stratum ranking of plant species of forest on Glenwood beach ridge east of Kemil Road--SE¼ NW¼ SW¼, section 16, T 37 N, R 5 W, Tremont Unit.	3-138
Table 3- 52	Stratum ranks of vegetation of forest stand on Glenwood beach ridge just west of Kemil Road--NE¼ SE¼ SE¼, section 17, T 37 N, R 5 W, Tremont Unit.	3-140
Table 3- 53	Stratum ranking of plant species of upland forest on Glenwood beach ridge west of where horse trail begins and ends--SE¼ NW¼, section 20, T 37 N, R 5 W, Tremont Unit.	3-142
Table 3- 54	Stratum ranking of plant species of forest in lowland along Glenwood beach ridge west of where horse trail begins and ends--SE¼ NW¼, section 20, T 37 N, R 5 W, Tremont Unit.	3-144
Table 3- 55	Stratum ranks of vegetation of swamp forest patches between Glenwood and Calumet beach ridges east of Kemil Road--SE¼ SW¼ NW¼, section 16, T 37 N, R 5 W, Tremont Unit.	3-148
Table 3-56A	Invertebrates taken in samples collected July 22, 1980, from forest on Calumet beach ridge west of Kemil Road--SE¼ NW¼ SW¼, section 16, T 37 N, R 5 W, Tremont Unit.	3-151
Table 3-56B	Invertebrates taken in abundance from forest on Calumet beach ridge west of Kemil Road, Tremont Unit.	3-153
Table 3-56C	Trophic levels of invertebrates collected in abundance from forest on Calumet beach ridge west of Kemil Road, Tremont Unit.	3-153
Table 3-57A	Invertebrates taken in samples collected July 22, 1980, from forest on Glenwood beach ridge west of where horse trail begins and ends--SE¼ NW¼, section 20, T 37 N, R 5 W, Tremont Unit.	3-154
Table 3-57B	Invertebrates taken in abundance from forest on Glenwood beach ridge west of where horse trail begins and ends, Tremont Unit.	3-156
Table 3-57C	Trophic levels of invertebrates collected in abundance from forest on Glenwood beach ridge west of where horse trail begins and ends, Tremont Unit.	3-156

Table		Page
Table 3- 58	Stratum ranks of vegetation of forest stand on Lake Border moraine just west of lakeshore headquarters--center of W½ SE¼ NE¼, section 27, T 37 N, R 6 W, Bailly Unit.	3-157
Table 3- 59	Stratum ranks of vegetation of forest on uplands adjoining Little Calumet River valley east of Ind. 49--at center of W margin of SW¼ SE¼, section 28, T 37 N, R 6 W, Bailly Unit.	3-161
Table 3- 60	Stratum ranks of vegetation of eastern portion of forest stand of Blue Heron Rookery Unit--N½ NW¼ SE¼, section 26, T 37 N, R 5 W.	3-163
Table 3- 61	Stratum ranks of vegetation of western portion of forest stand of Blue Heron Rookery Unit--SE¼, section 27, T 37 N, R 5 W.	3-167
Table 3- 62	Stratum ranks of woody plants of gallery forest along banks of Little Calumet River in Blue Heron Rookery Unit and of herbaceous plants found there but not in adjoining dense forest.	3-171
Table 3- 63	Stratum ranks of vegetation of forest stand north of Pinhook Bog--SE¼ NE¼ NW¼, section 35, T 37 N, R 4 W.	3-173
Table 3- 64	Stratum ranks of vegetation of forest stand south of Pinhook Bog--NW¼ NE¼ SW¼, section 35, T 37 N, R 4 W.	3-175
Table 3-65A	Invertebrates taken in samples collected July 23, 1980, from forest stand on Lake Border moraine just west of Lakeshore headquarters--center of W½ SE¼ NE¼, section 27, T 37 N, R 6 W, Bailly Unit.	3-178
Table 3-65B	Invertebrates taken in abundance from forest on Lake Border moraine just west of lakeshore headquarters, Bailly Unit.	3-180
Table 3-65C	Trophic levels of invertebrates collected in abundance from forest on Lake Border moraine just west of lakeshore headquarters, Bailly Unit.	3-180
Table 3-66A	Invertebrates taken in samples collected July 29, 1980, from eastern portion of forest stand of Blue Heron Rookery Unit--N½ NW¼ SE¼, section 26, T 37 N, R 5 W.	3-181
Table 3-66B	Invertebrates taken in abundance from eastern portion of forest stand of Blue Heron Rookery Unit.	3-182
Table 3-66C	Trophic levels of invertebrates collected in abundance from eastern portion of forest stand of Blue Heron Rookery Unit.	3-182

Table		Page
Table 3- 67	Stratum ranks of plant species of oak savannah portions of Hoosier Prairie.	3-184
Table 3- 68	Stratum ranks of plant species of mesic prairie portions of Hoosier Prairie.	3-186
Table 3- 69	Stratum ranks of plant species of wet prairie portions of Hoosier Prairie.	3-191
Table 3- 70	Stratum ranks of plant species of open aspen-willow thicket along eastern margin of Hoosier Prairie south of Main Street--SE¼ NE¼ NW¼, section 3, T 35 N, R 9 W.	3-192
Table 3- 71	Stratum ranks of plant species of marsh patches of Hoosier Prairie.	3-194
Table 3-72A	Invertebrates taken in samples collected July 23, 1979, from oak savannah portion of Hoosier Prairie.	3-195
Table 3-72B	Invertebrates taken in abundance from oak savannah portion of Hoosier Prairie.	3-197
Table 3-72C	Trophic levels of invertebrates collected in abundance from oak savannah portion of Hoosier Prairie.	3-197
Table 3-73A	Invertebrates taken in samples collected July 23, 1979, from open aspen-willow thicket along eastern margin of Hoosier Prairie--SE¼ NE¼ NW¼, section 3, T 35 N, R 9 W.	3-198
Table 3-73B	Invertebrates taken in abundance from open aspen-willow thicket along eastern margin of Hoosier Prairie.	3-200
Table 3-73C	Trophic levels of invertebrates collected in abundance from open aspen-willow thicket along eastern margin of Hoosier Prairie.	3-200
Table 3-74A	Ranks of vegetation in and around the easternmost intradunal pond of West Unit west of Ogden Dunes--NE¼ SE¼ SE¼, section 27, T 37 N, R 7 W.	3-203
Table 3-74B	Counts of plankta in measured sample from the easternmost intradunal pond of West Unit west of Ogden Dunes--NE¼ SE¼ SE¼, section 27, T 37 N, R 7 W.	3-203
Table 3-74C	Counts of macroscopic animals collected in half hour from littoral zone of the eastern most intradunal pond of West Unit west of Ogden Dunes--NE¼ SE¼ SE¼, section 27, T 37 N, R 7 W.	3-203

Table		Page
Table 3-75A	Ranks of vegetation in and around the second from the east intradunal pond of West Unit west of Ogden Dunes--center of S margin of NW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.	3-204
Table 3-75B	Counts of plankta in measured sample from the second from the east intradunal pond of West Unit west of Ogden Dunes--center of S margin NW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.	3-205
Table 3-75C	Counts of macroscopic animals collected in half hour from littoral zone of the second from the east intradunal pond of West Unit west of Ogden Dunes--center of S margin of NW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.	3-205
Table 3-76A	Ranks of vegetation in and around the middle intradunal pond of West Unit west of Ogden Dunes--center of W margin of SW¼ SW¼ SE¼, section 27, T 37 N, R 7 W.	3-206
Table 3-76B	Counts of plankta in measured sample from the middle intradunal pond of West Unit west of Ogden Dunes--center of W margin of SW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.	3-206
Table 3- 76C	Counts of macroscopic animals collected in half hour from littoral zone of the middle intradunal pond of West Unit west of Ogden Dunes--center of W margin of SW¼ SW¼ SE¼, section 27, T 37 N, R 7 W.	3-207
Table 3-77A	Ranks of vegetation in and around the second from the west intradunal pond of West Unit west of Ogden Dunes--center of S½ SE¼ SW¼, section 27, T 37 N, R 7 W.	3-208
Table 3-77B	Counts of plankta in measured sample from the second from the west of intradunal pond of West Unit west of Ogden Dunes--center of S½ SE¼ SW¼, section 27, T 37 N, R 7 W.	3-208
Table 3-77C	Counts of macroscopic animals collected in half hour from littoral zone of the second from the west intradunal pond of West Unit west of Ogden Dunes--center of S½ SE¼ SW¼, section 27, T 37 N, R 7 W.	3-208
Table 3-78A	Ranks of vegetation in and around the westernmost intradunal pond of West Unit west of Ogden Dunes--center of S½ SW¼ SW¼, section 27, T 37 N, R 7 W.	3-209
Table 3-78B	Counts of plankta in measured sample from the westernmost intradunal pond of West Unit west of Ogden Dunes--center of S½ SW¼ SW¼, section 27, T 37 N, R 7 W.	3-210

Table		Page
Table 3-78C	Counts of macroscopic animals collected in half hour from littoral zone of the westernmost intradunal pond of West Unit west of Ogden Dunes--center of S½ SW¼ SW¼, section 27, T 37 N, R 7 W.	3-210
Table 3-79A	Ranks of vegetation in and around intradunal pond of West Unit east of United States Steel--NE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.	3-212
Table 3-79B	Counts of plankta in measured sample from intradunal pond of West Unit east of United States Steel--NE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.	3-213
Table 3-79C	Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of West Unit east of United States Steel--NE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.	3-213
Table 3-80A	Ranks of vegetation in and around intradunal pond of West Unit east of United States Steel slag pile--SE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.	3-214
Table 3-80B	Counts of plankta in measured sample from intradunal pond of West Unit east of United States Steel slag pile--SE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.	3-215
Table 3-80C	Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of West Unit east of Unied States Steel slag pile--SE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.	3-215
Table 3-81A	Ranks of vegetation in and around intradunal pond of West Unit just north of Grand Calumet River--center of SW¼ NW¼, section 31, T 37 N, R 7 W.	3-217
Table 3-81B	Counts of plankta in measured sample from intradunal pond of West Unit just north of Grand Calumet River--center of SW¼ NW¼, section 31, T 37 N, R 7 W.	3-218
Table 3-81C	Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of West Unit just north of Grand Calumet River--center of SW¼ NW¼, section 31, T 37 N, R 7 W.	3-218
Table 3- 82	Ranks of vegetation in and around Grand Calumet River lagoon in West Unit--NE¼ NE¼ NW¼, section 31, T 37 N, R 7 W.	3-220

Table		Page
Table 3-83A	Ranks of vegetation in and around intradunal pond of Miller Woods between Grand Calumet River and Indiana Harbor Belt tracks--center of SE¼ NW¼, section 31, T 37 N, R 7 W.	3-220
Table 3-83B	Counts of plankta in measured sample from intradunal pond of Miller Woods between Grand Calumet River and Indiana Harbor Belt tracks--center of SE¼ NW¼, section 31, T 37 N, R 7 W.	3-221
Table 3-83C	Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of Miller Woods between Grand Calumet River and Indiana Harbor Belt tracks--center of SE¼ NW¼, section 31, T 37 N, R 7 W.	3-222
Table 3-84A	Ranks of vegetation in and around intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SE¼ NE¼ NW¼, section 1, T 36 N, R 8 W.	3-222
Table 3-84B	Counts of plankta in measured sample from intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SE¼ NE¼ NW¼, section 1, T 36 N, R 8 W.	3-223
Table 3-84C	Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SE¼ NE¼ NW¼, section 1, T 36 N, R 8 W.	3-223
Table 3-85A	Ranks of vegetation in and around intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SW¼ NE¼ NE¼, section 1, T 36 N, R 8 W.	3-225
Table 3-85B	Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SW¼ NE¼ NE¼, section 1, T 36 N, R 8 W.	3-225
Table 3-86A	Ranks of vegetation in and around Long Lake--center of section 34, T 37 N, R 7 W.	3-227
Table 3-86B	Counts of plankta in measured sample from Long Lake--center of section 34, T 37 N, R 7 W.	3-228
Table 3-86C	Counts of macroscopic animals collected in half hour from littoral zone of Long Lake--center of section 34, T 37 N, R 7 W.	3-228
Table 3-87A	Ranks of vegetation in and around pond #19 in Cowles Unit--SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W.	3-230

Table		Page
Table 3-87B	Counts of plankta in measured sample from pond #19 in Cowles Unit--SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W.	3-230
Table 3-87C	Counts of macroscopic animals collected in half hour from littoral zone of pond #19 in Cowles Unit--SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W.	3-231
Table 3-88A	Ranks of vegetation in and around pond #7 in Cowles Unit--center of W margin of SW¼, section 22, T 37 N, R 6 W.	3-231
Table 3-88B	Counts of plankta in measured sample from pond #7 in Cowles Unit--center of W margin of SW¼, section 22, T 37 N, R 6 W.	3-232
Table 3-88C	Counts of macroscopic animnals collected in half hour from littoral zone of pond #7 in Cowles Unit--center of W margin of SW¼, section 22, T 37 N, R 6 W.	3-232
Table 3-89A	Ranks of vegetation in and around pond #5 in Cowles Unit--NE¼ NE¼ SW¼, section 21, T 37 N, R 6 W.	3-233
Table 3-89B	Counts of plankta in measured sample from pond #5 in Cowles Unit--NE¼ NE¼ SW¼, section 21, T 37 N, R 6 W.	3-233
Table 3-89C	Counts of macroscopic animals collected in half hour from littoral zone of pond #5 in Cowles Unit--NE¼ NE¼ SW¼, section 21, T 37 N, R 6 W.	3-234
Table 3-90A	Ranks of vegetation in and around pond #2 in Cowles Unit--center of W½ SE¼, section 21, T 37 N, R 6 W.	3-236
Table 3-90B	Counts of plankta in measured sample from pond #2 in Cowles Unit--center of W½ SE¼, section 21, T 37 N, R 6 W.	3-236
Table 3-90C	Counts of macroscopic animals collected in half hour from littoral zone of pond #2 in Cowles Unit--center of W½ SE¼, section 21, T 37 N, R 6 W.	3-236
Table 3-91A	Ranks of vegetation in and around ponds #1 and #3 in Cowles Unit--SW¼ NW¼ SW¼, section 21, T 37 N, R 6 W.	3-237
Table 3-91B	Counts of plankta in measured sample from ponds #1 and #3 in Cowles Unit--SW¼ NW¼ SW¼, section 21, T 37 N, R 6 W.	3-237
Table 3-91C	Counts of macroscopic animals collected in half hour from littoral zone of ponds #1 and #3 in Cowles Unit--SW¼ NW¼ SW¼, section 21, T 37 N, R 6 W.	3-237

Table		Page
Table 3-92A	Ranks of vegetation in and around pond west of Pinhook Bog--SE¼ SW¼ NW¼, section 35, T 37 N, R 4 W.	3-239
Table 3-92B	Counts of macroscopic animals collected in half hour from littoral zone of pond west of Pinhook Bog--SE¼ SW¼ NW¼, section 35, T 37 N, R 4 W.	3-239
Table 3- 93	Counts of macroscopica animals collected in half hour along shoreline and from objects on the bottom of the Little Calumet River in the Blue Heron Rookery Unit--NW¼ NW¼ SE¼, section 27, T 37 N, R 5 W.	3-240
Table 3- 94	Counts of macroscopic animals collected in half hour along shoreline and from objects on the bottom of the Little Calumet River in the Bailly Unit--SE¼ NE¼ NW¼, section 33, T 37 N, R 6 W.	3-240
Table 3- 95	Stratum ranks of vegetation of marsh in southwest portion of West Unit--SE¼ SE¼ NW¼, section 1, T 36 N, R 8 W.	3-243
Table 3- 96	Stratum ranks of vegetation of small marsh in West Unit south of U.S. 12 and west of County Line Road--NE¼ NW¼ SE¼, section 5, T 36 N, R 7 W.	3-243
Table 3- 97	Stratum ranks of vegetation of marsh in West Unit south of U.S. 12 and east of County Line Road--center of N½ SW¼ SW¼, section 34, T 37 N, R 7 W.	3-244
Table 3- 98	Stratum ranks of vegetation of marsh in West Unit south of U.S. 12 and east of County Line Road--¼ mile E of SW corner, section 34, T 37 N, R 7 W.	3-244
Table 3- 99	Stratum ranks of vegetation of marsh in West Unit south of U.S. 12 and east of County Line Road--center of SW¼, section 34, T 37 N, R 7 W.	3-246
Table 3-100	Stratum ranks of plant species of marsh in West Unit north of U.S. 12 and west of County Line Road--NW¼ SW¼ SE¼, section 33, T 37 N, R 7 W.	3-247
Table 3-101	Stratum ranks of plant species of marsh in West Unit south of Long Lake--center of NW¼ SW¼, section 34, T 37 N, R 7 W.	3-248
Table 3-102	Stratum ranking of plant species of Great Marsh in Cowles Unit east of Mineral Springs Road--NE¼ NW¼ SW¼, section 23, T 37 N, R 6 W.	3-250
Table 3-103	List of plant species observed in marsh in East Unit between Beverly Shores Drive and the South Shore tracks--center of section 2, T 37 N, R 4 W.	3-251

Table		Page
Table 3- 104	List of shrubs and herbs observed in marsh in East Unit between U.S. 12 and South Shore tracks just west of Michigan City--center of SW¼ NW¼, section 31, T 38 N, R 4 W.	3-253
Table 3- 105	Stratum ranking of plant species of small marsh in West Unit northwest of Long Lake--NE¼ NW¼ SW¼, section 34, T 37 N, R 7 W.	3-253
Table 3- 106	Stratum ranking of vegetation of a small marshy area in Cowles Unit east of NIPSCO sand dike--NW¼ SE¼ SW¼, section 22, T 37 N, R 6 W.	3-253
Table 3- 107	Stratum ranking of plant species of marsh just south of West Road in Dune Acres--SW¼ NE¼ NW¼, section 22, T 37 N, R 6 W.	3-254
Table 3- 108	Stratum ranks of vegeation in marshy area east of Mineral Springs Road in Dune Acres--NE¼ NW¼ NW¼, section 23, T 37 N, R 6 W.	3-254
Table 3- 109	Stratum ranking of plant species in marsy areas beyond Lupine Lane and Pine Lane in Dune Acres--SE¼ NE¼ NW¼, section 23, T 37 N, R 6 W, and SE¼ SW¼ SE¼, section 14, T 37 N, R 6 W.	3-256
Table 3- 110	Stratum ranks of vegetation in swamp forest on floodplain of Little Calumet River in Bailly Unit--center of N margin of NE¼ NE¼, section 34, T 37 N, R 6 W.	3-258
Table 3- 111	Stratum ranks of vegetation in swamp forest on floodplain of Little Calumet River in Bailly Unit east of Indiana 149--SE¼ NE¼ NW¼, section 33, T 37 N, R 6 W.	3-260
Table 3- 112	Stratum ranks of vegetation in swamp forest north of South Shore tracks just east of State Park Road--NW¼ NW¼ NW¼, section 16, T 37 N, R 5 W.	3-262
Table 3- 113	Stratum ranks of vegetation in swamp forest north of South Shore tracks along Service Road--center of S½ SW¼, section 9, T 37 N, R 5 W.	3-264
Table 3- 114	Stratum ranks of plant species in portion of swamp forest west of Waverly Road dominated by oak and blackgum--NW¼ NE¼ NE¼, section 23 T 37 N, R 6 W.	3-266

Table		Page
Table 3-115A	Stratum ranks of tree species in portion of swamp forest west of Waverly Road dominated by swamp white oak--SW¼ NE¼ NE¼, section 23, T 37 N, R 6 W.	3-267
Table 3-115B	List of herbs in portion of swamp forest west of Waverly Road dominated by swamp white oak that were not found in adjacent portions.	3-267
Table 3- 116	Stratum ranks of plant species in portion of swamp forest west of Waverly Road dominated by red maple--NW¼ NE¼ SE¼, section 23, T 37 N, R 6 W.	3-268
Table 3- 117	Stratum ranks of plant species of swamp forest between Waverly Road and Indiana 49--S½ NW¼, section 24, T 37 N, R 6 W.	3-271
Table 3-118A	Invertebrates taken in samples collected July 23, 1980, from swamp forest on floodplain of Little Calumet River in Bailly Unit--SE¼ NE¼ NW¼, section 33, T 37 N, R 6 W.	3-273
Table 3-118B	Invertebrates taken in abundance from swamp forest on floodplain of Little Calumet River in Bailly Unit.	3-275
Table 3-118C	Trophic levels of invertebrates collected in abundance from swamp forest on floodplain of Little Calumet River in Bailly Unit.	3-275
Table 3-119A	Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from swamp forest dominated by red maple southeast of Cowles Bog--S½ SE¼ SE¼, section 22, T 37 N, R 6 W. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).	3-276
Table 3-119B	Invertebrates collected in four of six sample years from swamp forest dominated by red maple southeast of Cowles Bog.	3-282
Table 3-119C	Trophic levels of invertebrates collected in four of six sample years from swamp forest dominated by red maple southeast of Cowles Bog.	3-283
Table 3- 120	A list of contrasting characters used to distinguish bogs from marshes and swamps. From Dansereau and Segadas-Vianna (1952).	3-285
Table 3- 121	Stratum ranks of vegetation of swamp forest of Cowles Bog basin north and west of bog center--center of NW¼ SE¼, section 22, T 37 N, R 6 W.	3-289

Table		Page
Table 3- 122	Stratum ranking of plant species at the center of Cowles Bog--S margin of NW¼ NE¼ SE¼, section 22, T 37 N, R 6 W.	3-291
Table 3- 123	Stratum ranks of vegetation of Cowles Bog basin between the bog center and Mineral Springs Road--NE¼ NE¼ SE¼, section 22, T 37 N, R 6 W.	3-293
Table 3- 124	Stratum ranks of vegetation of Pinhook Bog--center of section 35, T 37 N, R 4 W--as determined by different groups.	3-295
Table 3-125A	Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from swamp forest west of Cowles Bog--center of NW¼ SE¼, section 22, T 37 N, R 6 W.	3-297
Table 3-125B	Invertebrates collected in four of six sample years from swamp forest west of Cowles Bog.	3-303
Table 3-125C	Trophic levels of invertebrates collected in four of six sample years from swamp forest west of Cowles Bog.	3-304
Table 3-126A	Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from marsh south of center of Cowles Bog--NE¼ SW¼ SE¼, section 22, T 37 N, R 6 W. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).	3-305
Table 3-126B	Invertebrates collected in four of six sample years from marsh south of center of Cowles Bog.	3-307
Table 3-126C	Trophic levels of invertebrates collected in four of six sample years from marsh south of center of Cowles Bog.	3-307
Table 3-127A	Trophic levels of invertebrates collected July 29, 1980, from Pinhook Bog.	3-308
Table 3-127B	Invertebrates taken in abundance from Pinhook Bog.	3-309
Table 3-127C	Trophic levels of invertebrates collected in abundance from Pinhook Bog.	3-309
Table 3- 128	An annotated list of amphibians known to occur, or possibly to occur, in the Indiana dunes area.	3-312
Table 3- 129	An annotated list of reptiles known to occur, or possibly to occur, in the Indiana dunes area.	3-313

Table		Page
Table 3- 130	Counts of amphibians and reptiles collected and observed in six years by Ecological Services of Texas Instruments Incorporated at eight sample locations near Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).	3-316
Table 3- 131	An annotated list of the birds of the Indiana Dunes National Lakeshore. Prepared by Chicago Audubon Society. 1980 revision.	3-317
Table 3- 132	A summary of Christmas bird count data for the dunes area: Michigan City counts, 1949-1962; Indiana Dunes National Lakeshore counts, 1972-1979.	3-320
Table 3- 133	A summary of Indiana Dunes National Lakeshore Big Day bird count data.	3-323
Table 3- 134	A summary of Indiana Dunes National Lakeshore breeding bird census data.	3-337
Table 3- 135	An annotated list of birds known to nest, or possibly to nest, in the Indiana dunes area.	3-340
Table 3- 136	An annotated list of mammals known to occur, or possibly to occur, in the Indiana dunes area.	3-347
Table 3- 137	Counts of mammals collected and observed in six years by Ecological Services of Texas Instruments Incorporated at eight sample locations near Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).	3-350

List of Figures

Figure		Page
3-1	Textbook illustrations of succession in the Lake Michigan dunes area.	3-21
3-2	Alternative paths of succession in the dunes	3-23

Biological Studies in the Indiana Dunes

As is commonly known, investigations in the Indiana Dunes played an important role in making ecology a modern dynamic science. Pioneering studies were made by Prof. Henry Chandler Cowles of the University of Chicago of the dunes along the southern and eastern shores of Lake Michigan. In his analysis published at the turn of the century, Cowles (1899, 1901) presented evidence that plant communities of the dunes follow one another in a recognizable pattern: the dynamic concept of succession. One of Cowles' colleagues, Victor E. Shelford, an animal ecologist, soon followed up on this work (Shelford 1907, 1912a, 1912b) and described in detail (Shelford, 1913) how animals are intimately involved in this process of succession as well as exhibiting a successional pattern themselves. Virtually every American textbook in ecology, and many introductory biology books at both the high school and college level, describe the pattern of succession revealed in these studies and often include diagrams of it (see Fig. 3-1).

Being near to Chicago and offering a variety of unusual habitats, the dunes area was, and continues to be, a mecca for naturalists. Serving the broad interests of this group, and presenting a good survey of the ecology of the dunes and neighboring habitats, was a semipopular book by Downing (1922). Particularly noticeable, both to the amateur and professional, was the unusual diversity of plant species in the dunes region, and early papers noting this fact (Peattie 1922, 1925, 1926; Lyon 1927, 1930) were soon followed by books by Pepoon (1927) and Peattie (1930) cataloging these plants. Numerous additions and updatings have since been made (Buhl 1934, 1935; Hull 1937, 1938, Tryon, 1936; Laughlin, 1953). The occurrence of a great variety of animals in the dunes habitats were also soon recognized, and a number of papers were written documenting that fact (Needham, 1904; Eifrig, 1918; Stoddard, 1921; Necker, 1939). The papers and books listed here are those dealing almost exclusively with organisms of the Lake Michigan duneland communities; a very long list of others (impractical to compile) include such organisms as part of a more general coverage.

Concurrent with the semipopular natural history interest there was continued a more scientifically oriented ecological interest. A series of publications by Fuller (e.g., 1911, 1912, 1925, 1935) considered the relationship of succession to evaporation, adaptations of dune plants, and the general pattern of succession in the dunes area. Laing (1958, 1967) described the characteristics of marram grass which make it an important dune builder. VanAsdall and Olmsted (1965) considered the ecology of bugseed, an important beach-foredune plant. Wohlrab et al. (1963) and Wohlrab and Tuveson (1965) discovered a succession of fungal species in the early stages of dunes community succession.

On the animal side, reference has been made to Shelford's work, the earliest of which (Shelford, 1907) dealt with the distribution of tiger beetles in the relation to stages of plant succession. Park (1930, 1931) extended the work with beetles relative to stages of plant

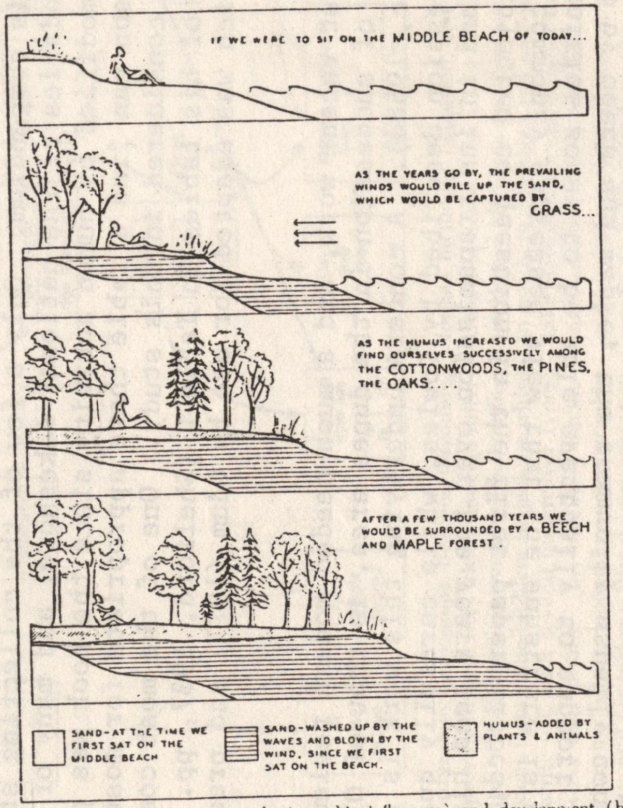


Fig. 206. Diagram of succession (physiographic influences) and development (biotic influences) operating through time in the forest-on-sand sere in the dunes of northern Indiana. (After Buchsbaum.)

Fig. 3-1. Textbook illustrations of succession in the Lake Michigan dunes area. A (above) from Allee et al. (1949); B (at right) from Odum (1971).

*Ecological succession of plants and invertebrates on the Lake Michigan dunes**



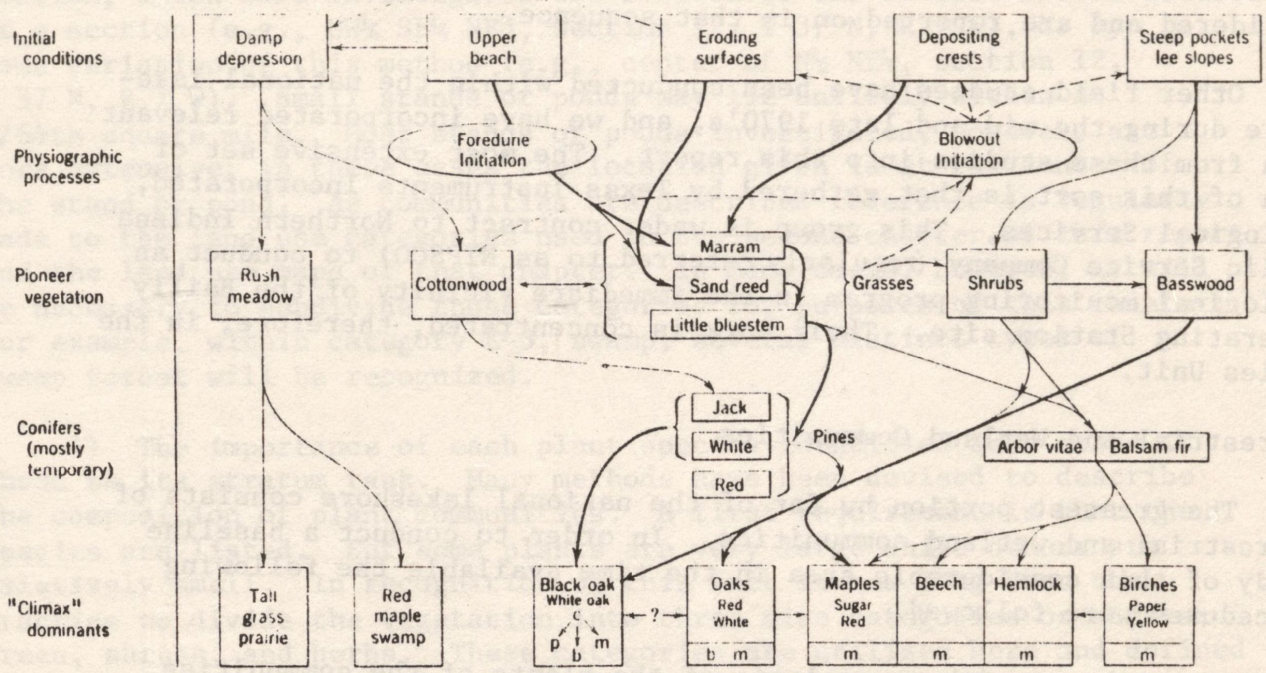
Invertebrates of ground strata	*Seral Stages* *Cottonwood–beach grass*	*Jack pine forest*	*Black oak dry forest*	*Oak and oak-hickory moist forest*	*Climax beech-maple forest*
White tiger beetle (*Cicindela lepida*)	••				
Sand spider (*Trochosa cinerea*)	••				
White grasshopper (*Trimerotropis maritima*)	••				
Long-horn grasshopper (*Psinidia fenestralis*)	••	••			
Burrowing spider (*Geolycosa pikei*)	••	••			
Digger wasps (*Bembex and Microbembex*)	••	••			
Bronze tiger beetle (*C. scutellaris*)		••			
Ant (*Lasius niger*)		••			
Migratory locust (*Melanoplus*)		••			
Sand locusts (*Ageneotettix* and *Spharagemon*)		••	••		
Digger wasp (*Sphex*)			••		
Ant-lion (*Cryptoleon*)			••		
Flatbug (*Neuroctenus*)			••		
Grasshoppers (six species not listed above)			••	••	••
Wireworms (*Elateridae*)			••	••	••
Snail (*Mesodon thyroides*)				••	••
Green tiger beetle (*C. sexguttata*)				••	••
Millipedes (*Fontaria* and *Spirobolus*)				••	••
Centipedes (*Lithobius, Geophilus, Lysiopetalum*)				••	••
Camel cricket (*Ceuthophilus*)				••	••
Ants (*Camponotus, Lasius umbratus*)				••	••
Betsy beetle (*Passalus*)				••	••
Sowbugs (*Porcellio*)				••	••
Earthworms (*Lumbricidae*)				••	••
Woodroaches (*Blattidae*)					••
Grouse locust (*Tettigidae*)					••
Cranefly larvae (*Tipulidae*)					
Wood snails (7 species not found in previous stages)					••

* From Shelford, 1913. A few species of invertebrates are listed to illustrate the general pattern of change; for more complete listing see his tables L to LV.

succession and emphasized in addition the seasonal and diurnal aspects. Studies of Talbot (1934) and Strohecker (1937) on the ecology of ants and orthopterans, respectively, of the Chicago region placed considerable emphasis on duneland species. Lowrie (1948) discovered that certain species of spiders are characteristically associated with the several stages of plant succession in the dunes. The most comprehensive lists of animals found in, and descriptions of, duneland animal communities are those eventually provided by Shelford (1937). Some are based on his own research, others on work done by other investigators prior to that date and cited in this compendium. Only a few of the collecting stations live within the boundaries of the national lakeshore, and many of the stations have been modified by human activity since the book was published, but with care a person can find a table there appropriate for most of the community types considered in this study. One of the most comprehensive and regularly cited of his tables in Table L (Shelford, 1937, pp. 252-253); it is this table which was adapted for use by Odum (1971) and presented in Fig. 3-1B above.

Some of the most recent work, and a much needed modern review of the general aspects of succession in the dunes area, is that of Olson (1958a, 1958b, 1958c, 1958d). A concern underlying this work is that the pattern of succession described by Cowles, while carefully qualified by Cowles himself, had in its transmission over the years been highly oversimplified. Subjected to question in the first paper listed, in particular, is the commonly expressed view that the substrate is modified by succeeding communities so as to be able eventually to support a mesophytic community dominated by beech and maple, the community usually considered climax for the area. Careful analysis of soils whose ages were determined by modern-day methods rather clearly discredits this notion. At the same time Olson uses modern sampling techniques to describe the dunes communities. Analysis of these descriptions in combination with age determinations reveal that there are many different paths that succession may follow in the dunes with many variables influence the pattern. A figure summarizing his conclusions in this respect is presented here as Fig. 3-2.

When a person reads through these earlier studies he is quickly struck by the fact that many of the areas in which the work was done no longer exist in their natural state. For example, Dunes Park was described by Cowles (1901) as by "far the best place to study living dunes in all phases" with "established dunes and undrained swamps... also well displayed." Dunes Park appears on the 1953 and earlier topographic maps at the center of section 30, T 37 N, R 6 W, just north of the South Shore railroad tracks--within present day Port of Indiana property. Fortunately, other areas that are often referred to are included within the boundaries of the Indiana Dunes National Lakeshore or the Indiana Dunes State Park. Outstanding among those in the National Lakeshore is Mineral Springs bog which is currently called Cowles bog in honor of the pioneer ecologist who helped to make this area so famous. The Indiana Dunes State Park is the location of many of the studies of recent decades.



—Alternative dune successions. Beaches, foredunes, and blowout dunes provide diverse sites which undergo different successions. Center of diagram gives oversimplified outline of "normal" succession, from dune-builders to jack or white pine to black oak–white oak with several undercover types: choke-cherry–poison ivy (c), "prairie" (p), blueberry-huckleberry (b), or mesophytic herbs (m), depending on topography, water table, and biotic and fire history. Wet depressions (*left*) and protected lee slopes and pockets (*right*) may lead to richer forests including basswood, red oak, and many mesophytic trees and herbs. Beech and hemlock are added in mesophytic pockets of Michigan and become more widespread northward; in northern Michigan red oak–white oak–blueberry (b) may take place of black oak on some dry dunes; pines, including red pine, are more widespread, and fir joins arbor vitae, basswood, and birches near lake. (Diagram published in *Elements of Ecology*, by G. L. CLARKE, from data of present writer. Reproduced here by permission of John Wiley & Sons, New York.)

Fig. 3-2. Alternatuve paths of succession in the dunes. From Olson (1958a) which should be consulted for further explanation.

Baseline Study Techniques

The studies described above provide a valuable data base and background against which more detailed analyses of the biotic communities of the Indiana Dunes National Lakeshore can be made. But one who reads these papers and books soon recognizes that they do not describe the various communities within the boundaries of the national lakeshore in any detail or with any specificity. In order to provide such a description, baseline data for the National Park Service, field studies were conducted by us* in 1974 and 1975 within the originally authorized national lakeshore boundaries and in 1978, 1979, and 1980 within the

*In this chapter "we" and "us" refer, when used in the context of field study, to the author and Prof. Gayton C. Marks of Valparaiso University. Prof. Marks is a systematic botanist whose services were fortunately obtained for most of the field work. His observations in the field and the many hours he spent checking identifications are greatly appreciated. This study would have been far less accurate and thorough without his contribution.

authorized expansion area. Emphasis was on communities of relatively undisturbed areas. Terrestrial, aquatic, and wetland communities were considered and are reported on in that sequence.

Other field studies have been conducted within the national lakeshore during the mid and late 1970's, and we have incorporated relevant data from these studies into this report. The most extensive set of data of this sort is that gathered by Texas Instruments Incorporated, Ecological Services, This group is under contract to Northern Indiana Public Service Company (regularly referred to as NIPSCO) to conduct an ecological monitoring program in the immediate vicinity of the Bailly Generating Station site. Their work is concentrated, therefore, in the Cowles Unit.

Terrestrial and Wetland Communities

The greatest portion by far of the national lakeshore consists of terrestrial and wetland communities. In order to conduct a baseline study of this considerable area in the time available the following procedures were followed.

1) We began with an analysis of the plants of the communities. This is an obvious and necessary part of any community study. And distinctions between the several types of terrestrial and wetland communities are typically made on the basis of their plants rather than on the basis of the kinds of animals present.

2) We focused on relatively undisturbed communities. There is considerable variation in the extent to which the land surface and communities lying within the boundaries of the national lakeshore have been modified by man. Areas in which this modification has been extensive--such as those which have been used for residential purposes or agriculture, and have accordingly been cleared, cut over, ditched, and/or plowed--received little if any attention in this study. Moreover, in listing plants of a stand and in taking invertebrate samples we avoided the margins adjoining roadbeds or cleared fields; to have included the species found there, many of them alien, would have lengthened our species lists considerably, but we did not see this as our goal.

3) We studied specific stands judged to be a good representation of those natural communities lying within the national lakeshore boundaries. The only other way in which even only the relatively undisturbed communities could have been investigated in the time allotted would have been to use a grid system and to take samples at regular intervals on the grid. The original intention had been to use this procedure, but after careful consideration it was decided that more useful data would come from a study of representative stands.

The stands, and the lakes and ponds considered in the aquatic section, which were investigated are located to the nearest 1/64th of a section (e.g., NW¼ SE¼ NE¼, section 12, T 37 N, R 7 W), or by some variation of this method (e.g., center of N½ NE¼, section 12, T 37 N, R 7 W). Small stands or ponds may lie entirely within a 1/64th square mile. Most stands or ponds investigated, however, are more extensive; in these cases the location given is at the center of the stand or pond. As communities are described reference is regularly made to the land use categories used in the second chapter of this report and the land use maps of that chapter. In many cases, however, it will be necessary to subdivide those categories for purposes of this chapter; for example, within category E-3, swamp, several distinct types of swamp forest will be recognized.

4) The importance of each plant species identified in a stand is shown as its stratum rank. Many methods have been devised to describe the composition of plant communities. A first requirement is that the species are listed. But some plants are very large while others are relatively small. In recognition of this fact it has long been the practice to divide the vegetation into three size categories or strata: trees, shrubs, and herbs. These categories are utilized here and defined as follows. Trees are defined as woody plants which have a diameter greater than 4 inches at breastheight; if any individual of a species reaches this size that species, including in the accounting those individuals which have not attained this size, is ranked in this stratum (the alternative is to make separate listings and rankings of reproductive stages of trees and time did not permit this). Shrubs are defined as woody plants--shrubs proper, tree species less than 4 inches in diameter at breast height, and vines--which extend at least half a meter vertically or laterally; if no individual of a tree species reaches 4 inches in diameter at breast height the species is listed and ranked in this stratum. Herbs are defined as non-woody plants, whether ferns, grasses, or forbs; woody species which have not attained the dimensions referred to above could be listed and ranked in this category, but such reproductive stages are taken into account in ranking the shrub and tree strata and are ranked in the herb stratum only if not ranked elsewhere.

But even within strata there are size differences; for example, one tree may barely exceed 4 inches in diameter at breastheight while another in our area may measure up to ten times that. Moreover individuals of some species are much more numerous than others. Thirdly, some species are distributed throughout a community while others are relatvely restricted in their distribution. These three aspects of a species' significance in a community are termed respectively its coverage, abundance, and frequency. Together these three comprise a species' importance. Coverage, abundance, frequency, and importance values are regularly calculated from sample plot data, but gathering such data can be very laborious and modifications are often adopted. Olson (1958a), for example, places emphasis on abundance in describing the plant communities of the dunes and uses an abundance scale which

approximates $\log_{10}$ of the number of stems per hectare. (It is worth noting that he observed certain species in the stands under study that were not included in the sample plots--a not unusual occurrence, and one of the disadvantages of the sample plot techniques--whose presence he indicated by special symbols in the tables.)

An alternative to the use of sample plots for determining importance is stratum ranking, a technique introduced by Lindsey (Lindsey et al., 1961) and used by him and his associates in describing communities in Natural Areas in Indiana and Their Preservation (Lindsey et al., 1969). Its main advantages are that it takes much less time than sample plots (thus there can be more coverage per unit of time) and that uncommon and rare species are not neglected. In this technique the species of a stratum are ranked in importance on a scale of 1, the lowest rank possible, to 9, the highest rank possible. This ranking is done on the basis of observations of abundance, coverage, and frequency as the investigator moves through the stand. In the hands of knowledgeable investigators this technique, though quite subjective, seems to give as accurate a description of a stand as sample plot methods, possibly an even more accurate one as far as uncommon or rare species are concerned. Rankings made by independent investigators or teams have been found to correspond very closely. Two of us (Krekeler and Marks) were involved in ranking in this study, and it was very rarely that we differed more than one unit on the scale. Table 3-1 provides a brief description of the ranks as Lindsey has defined them.

5) Samples were taken of macroscopic invertebrates--primarily insects and other arthropods--from a variety of terrestrial and wetland community types present in the national lakeshore. Texas Instruments Incorporated, Ecological Services, began this type of sampling in 1974 in the Cowles Unit (Texas Instruments 1975, pp. 1-22 ff.). We used the same sampling techniques as they, but sampled in the terrestrial and wetland community types of the national lakeshore which are not represented in or adjacent to the Cowles Unit. Samples were of three types.

a) Species were netted from plots approximately 100 m^2 in size. Standard insect nets with a nylon mesh were used to sweep above and around all accessible vegetation, and beating nets with muslin bags were swept through the vegetation. Specimens were killed and stored in 70% alcohol.

b) Species active at night and attracted to light were collected by light trapping. A large white sheet was suspended between poles or trees after dark and anchored to the ground. A double-mantled gas lantern was placed so as to provide maximum reflection from the sheet. Specimens landing on the sheet were removed and placed into 70% alcohol.

c) Ground litter and humus was trowelled from .25 m^2 plots and placed into plastic bags. This material was processed using standard Berlese methods: it is placed on a wire mesh in a large funnel, an

Table 3-1. A description of the ranks in the stratum ranking technique; quotations from Lindsey et al. (1961, 1969).

1. "SR 1 applies to a species for which only one individual was noted in the stand, regardless of its cover contribution."

2. "An SR 2 means at least two, but often several, individuals which are thus very infrequent numerically and provide in the aggregate quite inconsequential ground cover."

3. "As the balance between abundance and total cover of the species determines stratum rank, either 3 to several individuals furnishing substantial cover or more having lower aggregate cover would be called SR 3. Both cases would produce the same gross impression as to dominance-standing of the species."

4. "Since the balance between total cover and numerical abundance conveys the impression that leads to assignment of SR, the rank 4 would ordinarily designate a common, but far from dominant, species in its particular stratum, providing low-moderate total cover."

5. "Another species with equal numbers of individuals, but substantially greater total spread, or one with equal crown cover but more abundant, or simply with somewhat more of both, would be assigned the next higher rank" -- 5.

6. "In a stand having only two species sharing clear dominance, as beech and maple may, neither can exceed 7 in stratum rank, and if there is a marked difference between two such dominants, the lesser is SR 6." "Where dominance is shared nearly equally by a number of species...it may be that no one of them will rate higher than 6."

   "The progression from higher to lower ranks is accompanied in general by increase of numbers of species per rank. The increase in relative species influence that is expressed by a higher rank is not geometric, but is somewhat comparable to a log progression. The mid-scale ranks, while discernable in practice, cannot be fully conveyed in writing because an objectively quantitative basis is lacking."

7. "If no species is so outstanding, relative to others in its stratum, to deserve 8, more than one (but seldom more than two) species can be assigned SR 7."

8. "The rank 8 can be given to only one species in its stratum, that one so dominant that the next one after it can be rated no higher than 6."

9. "The maximum SR is reserved for a species dominating a practically pure stand in the given layer, i.e., no other species occurs there with SR exceeding 2."

incandescent lamp is placed above it, and specimens which move downward as the litter dries fall into a container of 70% alcohol placed below the funnel.

Specimens collected by the above techniques were subsequently identified in the laboratory. Identification was at least to the family level. In many cases identification was to the genus or species level; this was done especially when a rather large number of individuals or a species or genus were included in the sample.

6) The scientific names of the plants are from Swink and Wilhelm (1979) except in a few cases where we adopted Mohlenbrock's (1975) nomenclature. The common names are from various sources; in many cases where there is no vernacular name in use, the specific name has been translated to provide one. The genus is indicated in cases where there is great difficulty in determining species (e.g., Rubus, Vitis, Salix, Smilax) or where we did not at the time of observation have the opportunity (usually because the plants were not at an appropriate stage of development) to check the characteristics needed for species determination. In a given stand observations and ranking of the herbaceous vegetation were made typically in the spring, summer, and fall so that the seasonal aspects of the community could be documented. Trees and shrubs were ranked only once, in the summer. In the tables that follow, therefore, there is no subdivision of the trees or shrubs by dates, whereas there are subdivisions for the herbs. A given herb species is listed only once, on that date on which it was given its highest ranking.

The scientific names of the animals are from various sources. The family names are those used in the latest edition of Borror et al. (1976). References used for identification and nomenclature to genus and species level were: Needham and Heywood (1929), Odonata; Blatchley (1920), Helfer (1953), Orthoptera; Blatchley (1926), Slater and Baranowski (1978), Heteroptera; DeLong (1948), Hanna and Moore (1966), Homoptera; Arnett (1963), Blatchley (1910), Dillon and Dillon (1961), Jaques (1951), Coleoptera; Curran (1965), Diptera; Ehrlich and Ehrlich (1961), Holland (1903), Lepidoptera; Peterson (1951), insect larvae; Pratt (1935), invertebrates other than insects; Pennak (1978), aquatic invertebrates.

Aquatic Communities

Many of the procedures followed in the analysis of terrestrial and wetland communities were followed in the aquatic community studies. The following modifications and/or extensions, however, were utilized.

1) The vegetation was ranked according to its importance in each of three zones: a) Those plants rooted in substrate covered with water but which extend from the surface of the water are listed as emergent. b) Plants whose parts are found in or floating on the water are listed as aquatic. c) In many cases the vegetation of the most margin of the pond examined is quite distinct from that of the surrounding communities; this vegetation is listed as marginal.

2) Samples were taken of plankta in the littoral zone of the ponds and lake and along the margin of the stream that were studied. The plankta were collected in a fine-mesh plankton net from measured amounts of water so that the amounts as well as the kinds of plankta present could be determined.

3) Samples were taken of macroscopic animals in the littoral zone of the ponds and lake and along the margin of the stream that were studied. Half an hour was spent in each case netting animals from the surface, open water, vegetation, and objects/materials on the bottom. The total number of organisms, as well as the kinds of organisms, collected with this effort is recorded in the appropriate tables. While the number collected per unit of effort is a rather crude quantitative method, it provides much more information than a simple listing. Large differences between bodies of water in numbers of organisms collected are indicative of abundance differences which call for some sort of explanation.

Communities of the National Lakeshore

Data regarding the plant and animal communities of the national lakeshore are presented in three categories and in the following sequence: terrestrial communities, aquatic communities, and wetland communities.

Terrestrial Communities

The terrestrial communities are considered in a sequence which generally corresponds to the "normal" path of succession of communities in the dunes shown to the center of Fig. 3-2.

Open beach--Strictly speaking there are no independent biotic communities established on the bare sand of the open beach, coded A-1 on the land use maps. From time to time plants such as sea-rocket, bugseed, cocklebur, or even watermelon develop there from seeds that have been carried in. Even tree seedlings may develop. But there is no permanence; winter storms destroy these plants and new ones must be established the next year. The plants established along a stretch of beach in the West Unit west of Ogden Dunes are ranked in Table 3-2. The low stratum ranks assigned to the species found there is a reflection of their sparse growth.

Table 3-2. Stratum ranks of herbaceous vegetation on open beach in West Beach area--center of F½ SE¼, section 27, T 37 N, R 7 W.

Cakile edentula lacustris sea-rocket	3
Corispermum hyssopifolium bugseed	3
Ammophila breviligulata marram grass	2
Populus deltoides cottonwood	2
Prunus pumila sand cherry	2
Salix sp. willow	2

A variety of dead and displaced organisms (insects, crayfish, fish, etc.) may be found washed upon the beach, especially after storms. Utilizing these organisms, or one another, as food are predators and scavengers such as flesh flies, tiger beetles, ground beetles, rove beetles, robber flies, gulls, crows and skunks (see Shelford, 1937, pp. 218-220 and Table XXXVIII for detailed listings and descriptions). But once this supply is depleted they must look elsewhere. Some of the most abundant organisms present here -- both in number of individuals and in number of species -- are the beetles. Dr. N.M. Downie has collected beetles in this location for many years and has kindly shared his unpublished data with me. They are presented in Tables 3-3 and 3-4.

A condition exists along the beach in the Crescent Dune area of the East Unit which merits special attention. At this location (SW¼ NW¼ SE¼, section 30 of the East Unit, T 38 N, R 4 W) just above the present shoreline is exposed a bed of clay about 300 feet in width and several feet thick. Above and below this bed is typical lakeshore sand. A trickle of water flows along the surface of this bed, apparently from some distance inland, and provides sufficient water where it seeps to the surface in the otherwise dry and barren sand for the growth of an amazing number of plants. These plants are listed in Table 3-5. Fifty-six species of plants are found in an area approximately 300 feet long and 20 feetwide. Some, like marram grass, sea-rocket, and cottonwood, are not out of place near the foredunes; but others, like the cattails, common arrowhead, common reed, hard-stem bulrush, and smaller forget-me-not are plants of marshes.

Foredunes -- Immediately inland from the open beach, and parallel to it, are grass covered dune ridges called foredunes. They are coded B-1 on the land use maps. The formation of these ridges, as well as the topography of the first few thousand feet inland from the beach, is determined by the interaction of the vegetation, the wind, and the water and ice of Lake Michigan. Sand brought by currents to the southern shores of Lake Michigan is carried by wave action onto the beach. Winds which are of the highest velocity from the northwest blow the sand inland, and dried sand accumulates in the upper part of the beach to a height of several feet. As indicated above, annual plants such as sea-rocket and bugseed grow in this sand as unstable and as hostile as this environment may be. But the plant which plays a key role in altering the configuration of the sand is a perennial grass, marram grass (Ammophila breviligulata). Underground stems of this grass extend from plants established on the foredunes behind the beach into the sand on the beach, and at regular intervals roots grow into the sand and shoots with leaves extend into the air. The above-ground growth radically diminishes the capacity of the air currents to carry sand particles, hence sand accumulates at the base of the leaves (see Olson 1958b and 1958c for further details). As this happens, the plants continue to grow upward, sending out new roots and leaves, and thus avoid being smothered (see Laing, 1958, for a detailed discussion of the characteristics which make marram grass an effective dune builder). This gradual accumulation of sand, effected as it is by countless numbers of plants, results in the formation of a ridge of sand several yards high which lies parallel to the beach.

Table 3-3. List of beetles common on Indiana beaches of Lake Michigan in late May and early June. Unpublished data provided by courtesy of N.M. Downie.

Cicindelidae
- Cicindela repanda Dej.
- Cicindela hirticollis Say

Carabidae
- Calosoma externum Fab.
- Calosoma scrutator Fab.
- Calosoma willcoxi LeC.
- Dyschirius globulosus Say
- Bembidion carinula Chaud.
- Bembidion rapidum LeC.
- Pterostichus chalcites Say
- Pterostichus lucublandus Say
- Pterostichus melanarius Ill.
- Pterostichus caudicalis Say
- Calathus opaculus LeC.
- Agonum cupripenne Say
- Agonum placidum Say
- Amara convexa LeC.
- Amara angustata Say
- Harpalus pleuriticus Kby.
- Selenophorus opalinus LeC.
- Anisodactylus rusticus Say
- Anisodactylus merula Germ.
- Anisodactylus dulcicollis LaF.
- Anisodactylus sericea Harr.
- Stenolophus comma Fab.
- Diplocheila major LeC.
- Diplocheila assimilis LeC.
- Diplocheila striatopunctata LeC.
- Chlaenius tomentosus Say
- Chlaenius nemoralis Say
- Chlaenius pusillus Say
- Colliuris pennsylvanicus L.
- Lebia atriventris Say
- Lebia solea Hentz
- Galerita janus Fab.

Dytiscidae
- Hydroporus dichrous Melsh.
- Copelatus glyphicus Say

Hydrophilidae
- Tropisternus lateralis nimbatus Say

Staphylinidae
- Paederus littorarius Grav.
- Creophilus maxillosus villosus Grav.
- Philonthus cruentatus Grav.
- Philonthus fuscipennis Mann.
- Staphylinus mysticus Er.
- Aleochara bimaculata Grav.

Histeridae
- Hypocaccus sphaeroides LeC.
- Hypocaccus fraternus LeC.
- Hypocaccus mancus Say
- Hypocaccus patruelis LeC.
- Saprinus pennsylvanicus Payk.
- Euspilotus assimilis Payk.
- Margarinotus merdarius Hoff.

Scarabaeidae
- Attaenius-various spp.
- Aphodius-various spp.
- Phyllophaga-numerous spp.

Curculionidae
- Sphenophorus australis Chitt.
- Sphenophorus zeae Walsh
- Sphenophorus destructor Chitt.
- Sphenophorus callosus Oliv.

Table 3-4. List of beetles common on Indiana beaches of Lake Michigan between mid-July and the end of August. Unpublished data provided by courtesy of N.M. Downie.*

Cicindelidae
- Cicindela repanda Dej.
- Cicindela macra LeC.

Carabidae
- Bembidion carinula Chaud.
- Amara latior Kby.
- Harpalus caliginosus Fab.
- Selenophorus opalinus LeC.
- Diplocheila assimilis LeC.
- Chlaenius nemoralis Say
- Chlaenius pusillus Say
- Chlaenius lithophilus Say
- Colliuris pennsylvanicus L.

Hydrophilidae
- Tropisternus lateralis nimbatus Say
- Hydrocharis obtusatus Say

Histeridae
- Hypocaccus fraternus Say

Lucanidae
- Pseudolucanus capreolus L.

Scarabaeidae
- Pelidnota punctata L.
- Osmoderma eremicola Knoch

Cantharidae
- Chauliognathus marginatus Fab.

Elateridae
- Aeolus dorsalis Say

Coccinellidae
- Hippodamia convergens Guer.
- Hippodamia parenthesis Say
- Hippodamia tredecimpunctata L.
- Cycloneda sanguinea L.
- Ceratomegilla fuscilabris Muls.

Cerambycidae
- Parandra brunnea F.
- Orthosoma brunneum Forst.
- Graphisurus fasciatus DeG.
- Tetraopes tetrophthalmus Forst.
- Tetraopes quinquemaculatus Hald

Chrysomelidae
- Diabrotica virgifera LeC.
  (On 24 Aug. 1974 thousands of these were on the beach)
- Diabrotica undecimpunctata howardi Barber

Curculionidae
- Sphenophorus zeae Walsh

*The work on this list of Michael Brattain of Lafayette, Indiana, is hereby acknowledged.

Table 3-5. A list of plants found at a seep along the beach near Crescent Dune--SW¼ NW¼ SE¼, section 30, T 38 N, R 4 W. East Unit .

Ammophila breviligulata
marram grass
Artemisia caudata
wormwood
Aster azureus
azure aster
Aster ericoides
heath aster
Aster vimineus
small white aster
Bidens cernua
nodding bur-marigold
Bidens frondosa
beggar-ticks
Cakile edentula lacustris
sea-rocket
Calamovilfa longifolia
sand reedgrass
Carex hystericina
bottlebrush sedge
Carex normalis
right-angled sedge
Carex pensylvanica
Pennsylvania sedge
Chenopodium album
lamb's-quarters
Cirsium sp.
thistle
Cornus stolonifera
red-osier dogwood
Convolvulus sp.
bindweed
Crepis tectorum
hawksbeard
Panicum virgatum
switchgrass
Parthenocissus quinquefolia
Virginia creeper
Potentilla anserina
silverweed
Potentilla recta
rough-fruited cinquefoil
Rhus radicans
poison-ivy
Rosa blanda
meadow rose
Rumex sp.
dock
Sagittaria latifolia
common arrowhead
Salix sp.
willow
Saponaria officinalis
soapwort
Scirpus acutus
hard-stem bulrush
Cycloloma atriplicifolium
winged pigweed
Echinochloa crusgalli
barnyard grass
Elymus canadensis
nodding wild rye
Equisetum arvense
field horsetail
Equisetum hyemale affine
common scouring-rush
Erigeron strigosus
narrow-leaved daisy fleabane
Eupatorium perfoliatum
common boneset
Helianthus petiolaris
prairie sunflower
Impatiens biflora
touch-me-not
Iris virginica shrevei
wild iris
Juncus effusus solutus
common rush
Lactuca canadensis
wild lettuce
Monarda punctata villicaulis
horsemint
Myosotis laxa
smaller forget-me-not
Oenothera biennis
evening-primrose
Populus deltoides
cottonwood
Phragmites communis berlandieri
common reed
Solanum dulcamara
bittersweet nightshade
Solidago graminifolia
grass-leaved goldenrod
Solidago juncea
early goldenrod
Solidago rugosa rugosa
thin-leaved rough-stemmed goldenrod
Taraxacum officinale
dandelion
Tragopogon sp.
goat's-beard
Typha angustifolia
narrowleaf cattail
Typha latifolia
common cattail
Vitis sp.
wild grape
Xanthium strumarium
common cocklebur

An actively growing ridge is called a young foredune. When the water level of Lake Michigan is low and the shoreline is aggrading the growth of foredunes is promoted. When the lake level is high, however, as it was in the early and mid 1970s, shoreline erosion is common. This erosion regularly extends to the foredunes and wave cut cliffs are formed on the face of the foredunes. Even at high lake levels there are a few places where the shoreline is aggrading, and it is here where foredunes are growing. An example of this along the shoreline of the national lakeshore is immediately east of the Northern Indiana Public Service Company bulkhead at the Bailly generating station. At the extreme western boundary of the Cowles Unit at that location an open sand beach extends inland about 20 yards and a young foredune another 40 yards. This foredune extends several hundred yards to the east but becomes narrower and narrower and eventually disappears where erosion exceeds deposition. The plant community of this foredune is dominated by marram grass (Ammophila breviligulata), SR (stratum rank) 9. Sand reedgrass (Calamovilfa longifolia), wormwood (Artemesia caudata), and common scouring rush (Equisetum hyemale affine) each rank 2.

A similar situation exists just east of a jetty extending from the United States Steel Corporation property into Lake Michigan near the western border of the West Unit. A large triangular expanse of sand has accumulated on the east side of the jetty, and a community dominated by marram grass, stratum rank 8, covers approximately its inland half. Scattered cottonwood of shrub size, SR 3, extend above the grass; present in addition are sea rocket (Cakile edentula lacustris), SR 4, and bugseed (Corispermum hyssopifolium), SR 3.

In both the above cases the communities are almost pure stands of marram grass as is indicated by the stratum rank of 9 and 8. And where these communities are present there is a gradual rise in the elevation of sand from that on the open beach to the landward side of the communities. Some of this increase in elevation is attributable to the action of waves and wind, but much of it is undoubtedly due to the fact that the marram grass reduces the capacity of the wind to carry sand so that sand accumulates about it.

In the mid 1970s when the lake level was high, there were few, if any, areas other than the above along the shorelines of the national lakeshore where foredunes were actively growing. As the lake level has gradually receded in recent years the situation has changed. Along many stretches of the lakeshore sand has been and is being carried by wind action up to the wave cut foredune cliffs formed when the lake level was high. Growing commonly in this sand are sea-rocket and bugseed. As the sand piles up at the base of the foredune cliffs, marram grass rhizomes extend into it from plants established higher up on the foredune, and sand accumulates even more rapidly as shoots of the grass grow into the air. Thus the wave cut cliffs are gradually disappearing as new foredunes develop in front of them.

The sandbinding marram grass thus plays a key role, as is apparent in the preceding paragraphs, in the growth and eventual stabilization of foredunes. But Laing (1958) has demonstrated that marram grass does not thrive unless it continues to be covered with sand. This means that when marram grass has stabilized a foredune it becomes less important in the community than previously and that plants requiring a stable substrate can become established and attain high importance values. Grasses of importance on stable dunes are sand reedgrass and little bluestem; sand cherry and cottonwood are the most important shrubs and trees of such dunes.

Such stable or old foredunes lie behind the young foredune ridges. Sometimes they form ridges parallel to young foredune ridges; in other cases there is simply an accumulation of sand in mounds rather than an obvious series of ridges. The plant communities of some of these stable foredunes consist almost entirely of grasses and herbs, while in others there is an abundance of trees and/or shrubs. There are numerous old foredunes in the national lakeshore. Some of the best examples are as follows.

Immediately behind the young foredune described above which lies to the east of the United States Steel jetty and running parallel to the young foredune, is a stable foredune ridge. The vegetation of the community on this ridge is ranked in Table 3-6. Though marram grass is still most important grass, sand reedgrass and little bluestem are only slightly less important; and cottonwood trees and sand cherry shrubs, though widely scattered, are also of considerable importance.

Table 3-6. Stratum ranking of vegetation of stable foredune ridge east of United States Steel jetty--SW¼ NW¼ NE¼, section 36, T 37 N, R 8 W.

Populus deltoides cottonwood	4	Trees
Prunus pumila sand cherry	4	Shrubs
Ammophila breviligulata marram grass	7	Herbs 27 July 78
Calamovilfa longifolia sand reedgrass	6	
Andropogon scoparius little bluestem	5	
Solidago racemosa gillmani dune goldenrod	4	
Oenothera biennis evening-primrose	2	

Behind the old foredune ridge described in the previous paragraph, and extending eastward from there to the beach parking area, are several additional foredune ridges approximately parallel to the beach. They extend inland approximately 600 feet to the bare sand areas coded A-2 on the land use map. These foredunes themselves are coded B-1, B-2, D, F-2, and F-3 on the land use map. This is an indication of the diversity of these foredunes: at one extreme some are essentially covered with grass, while at the other extreme some have a considerable cover of trees, and in some of the depressions between ridges there is wet substrate vegetation. The vegetation (except for the wet substrate type in the depressions) of this group of foredunes is ranked in Table 3-7. In view of the numerous

habitat types in this community it is not surprising that the number of plants present is large. Note, however, that cottonwood, sand cherry, marram grass, sand reedgrass, and little bluestem are again among the most important plants; the only other plant achieving as high a rank as they is wild grape.

Table 3-7. Stratum ranks of vegetation of old foredune complex behind stable foredune ridge east of United States Steel jetty--SE¼ NE¼ NE¼, section 36, T 37 N, R 8 W.

Populus deltoides cottonwood	7	Trees
Vitis sp. wild grape	6	Shrubs
Prunus pumila sand cherry	5	
Cornus stolonifera red-osier dogwood	3	
Lonicera tatarica Tartarian honeysuckle	3	
Rhus radicans poison-ivy	3	
Celastrus scandens bittersweet	2	
Ptelea trifoliata hoptree	2	
Rhus aromatica fragrant sumac	2	
Salix spp. willow shrubs	2	
Juniperus communis depressa ground juniper	1	
Opuntia compressa prickly-pear	1	
Arabis lyrata rockcress	4	Herbs 23 May 79
Lithospermum caroliniense hairy puccoon	4	
Senecio aureus golden ragwort	4	
Senecio pauperculus balsam ragwort	4	
Tragopogon porrifolius salsify	2	
Cynoglossum officinale hound's-tongue	2	
Asparagus officinalis asparagus	1	
Lupinus perennis lupine	1	
Ammophila breviligulata marram grass	7	27 July 78
Calamovilfa longifolia sand reedgrass	7	
Andropogon scoparius little bluestem	6	
Asclepias syriaca common milkweed	5	

Table 3-7, continued

Artemisia caudata wormwood	3	
Asclepias verticillata whorled milkweed	3	
Asclepias tuberosa butterfly-weed	3	
Fragaria virginiana strawberry	3	
Elymus canadensis nodding wild rye	3	
Helianthus petiolaris prairie sunflower	3	
Oenothera biennis evening-primrose	3	
Panicum virgatum switchgrass	3	
Antennaria neglecta field pussytoes	2	
Erigeron strigosus narrow-leaved daisy fleabane	2	
Euphorbia corollata flowering spruse	2	
Monarda punctata villicaulis horsemint	2	
Verbascum thapsus common mullein	2	
Cirsium pitcheri sand thistle	1	
Solidago racemosa gillmani dune goldenrod	6	15 Sept. 79
Helianthus divaricatus woodland sunflower	3	
Anemone cylindrica candle anemone	2	
Solidago juncea early goldenrod	2	

A dune ridge just west of Ogden Dunes in the West Unit was covered in 1974 with the vegetation ranked in Table 3-8. The relative importance of little bluestem and sand reedgrass indicates that this is a dune which is partially stabilized, but the high ranking of marram grass indicates that it is still growing. By 1980 a large mound of sand had been piled up by the wind along the wave cut cliff facing the shoreline and an extensive mat of marram grass extends onto this mound. On a ridge behind the partially stabilized foredune at this location, on the other hand, is found the vegetation ranked in Table 3-9. The high rankings of cottonwood, sand cherry, and little bluestem and the absence of marram grass indicate that this is a foredune which has been stabilized for some time.

Just east of Ogden Dunes a comparable situation exists. The vegetation on the foredune adjacent to the open beach at that location in the northeasternmost portion of the West Unit is ranked in Table 3-10. The relative importance of cottonwood and sand reedgrass indicate stabilization but the high ranking of marram grass indicates continued growth. Moreover there is essentially a pure stand of marram grass on

Table 3-8. Stratum ranks of vegetation of a partially stabilized foredune in West Beach area--center of E½ SE¼, section 27, T 37 N, R 7 W.

Prunus pumila sand cherry	1	Shrubs
Ammophila breviligulata marram grass	8	Herbs 24 July 79
Andropogon scoparius little bluestem	5	
Calamovilfa longifolia sand reedgrass	4	
Asclepias syriaca common milkweed	3	
Solidago sp. goldenrod	3	
Oenothera biennis evening-primrose	1	

Table 3-9. Stratum ranks of vegetation of stable foredune in West Beach area--center of E½ SE¼, section 27, T 37 N, R 7 W.

Populus deltoides cottonwood	5	Trees
Prunus pumila sand cherry	6	Shrubs
Vitis sp. wild grape	4	
Salix sp. willow	3	
Andropogon scoparius little bluestem	8	Herbs 24 July 74
Solidago sp. goldenrod	4	
Asclepias syriaca common milkweed	3	
Antennaria sp. pussytoes	2	
Eupatorium perforliatum common boneset	2	
Cirsium pitcheri sand thistle	1	

Table 3-10. Stratum ranks of vegetation of a partially stabilized foredune just east of Ogden Dunes--SW¼ SE¼ NW¼, section 25, T 37 N, R 7 W.

Populus deltoides cottonwood	5	Trees
Ammophila breviligulata marram grass	7	Herbs 23 Aug. 78
Calamovilfa longifolia sand reedgrass	7	
Cakile edentula lacustris sea-rocket	3	
Corispermum hyssopifolium bugseed	3	
Helianthus petiolaris prairie sunflower	1	

the sand which is accumulating along the wave cut cliff facing the lake. A group of rolling dunes begins about 50 feet behind the face of the above dune and extends both to the east and west around a depression up to the relatively open sand of a healing blowout. The vegetation of these dunes is ranked in Table 3-11. The high rankings of cottonwood, little bluestem, and sand reedgrass and the low ranking of marram grass indicate that this is an area which has been stabilized for some time.

Finally, a stable foredune about ten yards in width lies behind the young foredune described above which is found just east of the Bailly generating plant in the Cowles Unit. Its vegetation is ranked in Table 3-12. Trees are scattered and of little importance; sand cherry is a relatively important shrub; little bluestem and sand reedgrass rank very high, while marram grass is absent. These latter points in particular indicate that this is a foredune which has been stabilized for some period of time.

Invertebrates have been collected from the foredune communities east of the Bailly generating station in the Cowles Unit by Ecological Services of Texas Instruments Incorporated each summer since 1974. Table 3-13 summarizes their collection data from the young foredunes (which they refer to as the "beach grass community"). Table 3-14 summarizes their collection data from the stable foredune (which they refer to as the "foredune community"). Several comments should be made regarding these collections relative to collections of invertebrates from other community types. In analyzing them we pay particular attention to which and how many families are represented, except in the case of the insect relatives where orders or classes are listed in the tables; in counts of families we will consider each of these orders and classes to represent a single family. Though genera and species are regularly included on the lists, the fact that they are listed in one year's collection and not in another does not mean that they were not present when not listed by simply that they were not identified to that level that particular year.

First of all, in order to simplify the analysis of composition we may list the organisms usually present in numbers and therefore regularly taken in collections from each of these two communities. If, for example, we list the organisms present in the majority of the years these two collections represent, that is in four of the six sample years, we arrive at the lists in Tables 3-13B and 3-14B.

In examining lists like these a basic concern is to know which trophic level a given family of organisms occupies, that is whether animals of this family feed on plants, are predatory on other animals, are scavengers, or are parasites. In some cases there is no problem: e.g., grasshoppers, both adults and nymphs, feed on plant materials. Other cases are a bit more difficult; e.g., the larvae of antlions prey upon ants and other insects which slide into the conical depressions they fashion in the sand whereas the food habits of the adult are relatively unimportant. In cases of this sort we shall list the organism in the category which is of importance, even though it may have been the adult which was collected. In still other cases the food habits of male and female and/or adults and immatures (e.g., mosquitoes) or of different

Table 3-11. Stratum ranks of vegetation of stable foredune complex just east of Ogden Dunes--SW¼ SW¼ NW¼, Section 25, T 37 N, R 7 W. West Unit .

Populus deltoides cottonwood	5	Trees
Juniperus virginiana creba red cedar	1	
Rhus radicans poison-ivy	4	Shrubs
Vitis sp. wild grape	4	
Celastrus scandens bittersweet	3	
Prunus pumila sand cherry	3	
Lithospermum caroliniense hairy puccoon	3	Herbs 25 May 79
Andropogon scoparius little bluestem	7	23 May 78
Calamovilfa longifolia sand reedgrass	5	
Ammophila breviligulata marram grass	3	
Asclepias syriaca common milkweed	3	
Artemisia caudata wormwood	3	
Saponaria officinalis soapwort	3	
Solidago juncea early goldenrod	4	21 Sept. 79
Solidago racemosa gillmani dune goldenrod	3	
Cycloloma atriplicifolium winged pigweed	2	
Helianthus petiolaris prairie sunflower	1	
Solidago speciosa showy goldenrod	1	

Table 3-12. Stratum ranks of vegetation of stable foredune east of Bailly generating station--NE¼ SE¼ NW¼, section 21, T 37 N, R 6 W, Cowles Unit.

Pinus banksiana jack pine	2	Trees
Populus deltoides cottonwood	2	
Quercus velutina black oak	2	
Prunus pumila sand cherry	4	Shrubs
Celastrus scandens bittersweet	3	
Arctostaphylos uva-ursi coactilis bearberry	2	
Opuntia compressa prickly-pear	2	
Arabis lyrata rockcress	4	Herbs - 22 April 74 14 Aug. 74
Andropogon scoparius little bluestem	7	
Calamovilfa longifolia sand reedgrass	7	
Lithospermum caroliniense hairy puccoon	4	
Artemisia caudata wormwood	3	
Asclepias syriaca common milkweed	3	
Asclepias tuberosa butterfly-weed	3	
Liatris aspera rough blazing-star	3	
Tradescantia ohiensis common spiderwort	3	
Euphorbia corollata flowering spurse	2	
Liatris cylindracea cylindric blazing-star	2	
Solidago juncea early goldenrod	4	21 Sept. 74
Aster azureus azure aster	2	
Elymus canadensis nodding wild rye	2	
Kuhnia eupatorioides corymbulosa false boneset	1	

Table 3-13A. Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from young foredune east of Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980), Cowles Unit.

	1974	1975	1976	1977	1978	1979
COLLEMBOLA						
Poduridae						x
Isotomidae	x		x		x	
Entomobryidae	x	x		x	x	
EPHEMEROPTERA						
Caenidae		x				
Baetidae	x					
ODONATA						
Aeschnidae		x				
Libellulidae	x	x				
Plathemis lydia		x				
Perithemis tenera		x				
Coenagrionidae	x	x				
Enallagma sp.		x	x	x		
Ischnura sp.						x
Nehalennia sp.			x			
ORTHOPTERA						
Acrididae	x	x				
Melanoplus sp.		x				
Tetigoniidae	x	x				
Neoconocephalus sp.						x
Gryllidae						
Oecanthus sp.				x		
Blattidae	x	x				
DERMAPTERA						
Forficulidae		x				
PSOCOPTERA						
Liposcelidae	x					
Psocidae	x					
Pseudocaeciliidae	x	x		x	x	
THYSANOPTERA						
Phloeothripidae	x	x				
Thrypidae	x	x	x		x	
HEMIPTERA						
Mesoveliidae						
Mesovelia sp.					x	
Miridae		x				
Lopidea sp.			x			
Trigonotylus ruficornis				x		
Nabidae	x					
Nabis sp.			x			
Reduviidae						
Zelus sp.						x
Phymatidae						
Phymata sp.					x	

Table 3-13 A continued

	1974	1975	1976	1977	1978	1979
HEMIPTERA (cont.)						
Tingidae						
Corythuca sp.	x					
Piesmatidae			x			
Piesma cinera sp.			x			
Lygaeidae						
Blissus leucopterus						x
Cymus sp.					x	
Ischnorhynchus resedae	x					
Lygaeus kalmii			x			
Nysius sp.			x			
Pentatomidae						x
Podops sp.	x					
Cydnidae						
Galgupha sp.	x					
HOMOPTERA						
Cicadellidae	x	x	x		x	x
Chlorotettix sp.						x
Dikraneura sp.				x		
Empoasca sp.					x	x
Macrosteles sp.				x		
M. divisa					x	x
M. fascifrons			x			
Polyamia sp.					x	
Scophoideus sp.						x
Cercopidae			x			x
Delphacidae		x	x		x	x
Cixiidae	x					
Psyllidae	x				x	
Aphididae	x		x			x
COLEOPTERA						
Cicindelidae						
Cicindela sp.	x					
C. dorsalis					x	
C. hirticollis	x					
C. repanda	x					
Carabidae	x	x				
Agonaderus sp.	x	x				
Anisodactylus sp.	x	x				
Anomoglossus sp.	x					
Chlaenius sp.	x					
Clivinia sp.	x					
Harpalus sp.	x					
Lebia viridis			x			
Platynus sp.	x				x	
Pterostichus sp.	x				x	
Stenocellus sp.	x					
Dytiscidae						
Agabus sp.	x					
Histeridae	x					
Hister sp.	x					

Table 3-13 A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-cont.						
Hydrophilidae						
Enochrus sp.	x					
Hydrochara sp.	x					
Tropisternus sp.	x					
Staphylinidae	x		x		x	
Stenus sp.	x					
Cantharidae						
Cantharis sp.	x					
Podabrus sp.	x					
Polemius sp.		x				
Lampyridae						
Ellychnia corrusca					x	
Photinus sp.		x	x			
Dermestidae			x			
Malachiidae	x					
Elateridae						
Agriotes oblongicollis						x
Conoderus vespertinus			x			
Limonius basillaris			x			
Throscidae						
Aulonothroscus sp.	x					
Helodidae						
Cyphon sp.	x			x		x
Prionocyphon sp.					x	
Scrites sp.					x	
Phalacridae	x					
Nitidulidae	x					
Coccinellidae						
Adalia bipunctata	x					
Chilocoris stigma	x					
Coleomegilla fuscilabris	x	x	x		x	x
Cycloneda sanguinea					x	
Hippodamia convergens	x		x	x	x	x
H. parentheses			x			
H. 13-punctata			x			
Hyperaspis sp.	x					
H. undulata				x	x	x
Scymnus sp.	x					
Anthicidae						
Anthicus sp.		x				
Notoxus sp.		x				
N. muripennis			x			
Pedilidae					x	
Macratia sp.	x		x			
Stereopalpus sp.						x
Mordellidae		x				
Tenebrionidae					x	
Xylopinus saperdioidea					x	
Melandryidae	x					
Symphora sp.					x	
Ptinidae						
Ptinus sp.	x					
Lucanidae						
Pseudolucanus sp.		x				

Table 3-13 A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-cont.						
Scarabaeidae			x			
Ataenius sp.	x				x	
Geotrupes sp.	x				x	
Macrodactylus subspinosus	x					
Maladera castanea		x				
Onthophagus orpheus					x	
Phyllophaga sp.	x				x	
Trichiotinus sp.	x					
Cerambycidae						
Parandra brunnea		x				
Anthribidae						
Ischnocerus sp.	x					
Curculionidae	x	x			x	
Calendra sp					x	
Hypera postica	x					
Sphenophorus sp.	x	x				
Scolytidae					x	
Chrysomelidae						
Acalymma vittata	x	x				
Altica sp.	x				x	
Chaetocnema minuta	x	x				x
Chrysochus auratus	x					
Crepidodera sp.	x					
Diabrotica 12-punctata	x			x		
D. virgifera				x		
Disonycha sp.				x		
D. pennsylvanica		x				
Longitarsus sp.				x		
Pachybrachis sp.						x
Plagiodera versicolor	x					
Phyllotreta sp.	x					
Psyllioides sp.	x					
NEUROPTERA						
Chrysopidae	x		x	x		
Hemerobiidae	x			x		
Myrmeliontidae	x	x	x	x	x	x
TRICHOPTERA						
Psychomyiidae	x					
Hydropsychidae	x			x		
Hydropsyche sp.						x
Hydroptilidae		x				
Leptoceridae	x	x				
Oecetis sp.						x
Triaenodes sp.						x
Phryganeidae						
Banksiola selina			x			
Limnephilidae	x					
LEPIDOPTERA						
Papilionidae						
Papilio glaucus	x			x		
P. polyxenes	x	x			x	

Table 3-13 A continued

	1974	1975	1976	1977	1978	1979
LEPIDOPTERA-cont.						
Pieridae						
Colias philodice	x	x	x	x	x	
Pieris rapae	x	x		x	x	
P. protodice				x		
Danaidae						
Danaus plexippus	x	x			x	
Nymphalidae						
Junonia coenia		x				
Limenetis archippus		x				
Lycaenidae						
Everes comyntas		x				
Hesperiidae						x
Ctenuchidae						
Scepsis fulvicollis	x					
Noctuidae	x	x				
Apatela sp.					x	
Catacula sp.	x					
Notodontidae						
Cerura borealis				x		
Pyralidae		x				
Tortricidae	x	x				
Micromoths			x	x	x	x
DIPTERA						
Tipulidae	x	x	x			x
Psychodidae	x	x		x		
Chaoboridae		x				
Chironomidae	x	x	x	x	x	x
Culicidae	x	x	x		x	x
Mycetophilidae		x				
Sciaridae	x	x			x	
Cecidomyiidae	x				x	
Ceratopogonidae	x				x	x
Xylophagidae		x				
Cyphomyia sp.			x			
Tabanidae						
Chrysops vittatus					x	
Mydidae						
Mydas clavatus					x	
Asilidae	x					
Efferia albibaris			x		x	x
Lonchopteridae	x					
Lonchoptera sp.		x				
Empididae	x					
Dolichopodidae	x	x				
Argyra sp.			x			
Asyndetus sp.				x		
Chrysotus sp.			x		x	
Condylostylus sp.			x			
Dolichopus sp.					x	x
Pipunculidae	x					
Alloneura sp.				x		x
Pipunculus sp.			x			
Syrphidae	x					
Otitidae						
Chaetopsis sp.		x	x			

Table 3-13 A continued

	1974	1975	1976	1977	1978	1979
DIPTERA-cont.						
Tephritidae						x
Sepsidae						
Sepsis sp.						x
Sciomyzidae	x					
Hoplodictya sp.			x			
Lauxaniidae		x				
Camptroprosopella sp.					x	
Homoneura sp.					x	
Minettia sp.					x	
Sapromyza sp.			x			
Sphaeroceridae	x	x	x			
Ephydridae	x	x	x			
Drosophilidae	x	x				
Drosophila sp.				x		
Chloropidae	x	x				
Diplotoxa sp.					x	
Hippelates sp.					x	
Meromyza sp.						x
Thaumatomyia sp.						x
Heleomyzidae		x				
Anthomyiidae		x				
Calliphoridae		x			x	x
Phaenicia sp.			x			
Muscidae	x	x	x		x	x
Musca domestica				x		x
Tachinidae						x
HYMENOPTERA						
Braconidae			x	x		
Ichneumonidae	x	x	x		x	x
Eulophidae	x					
Scelionidae					x	
Eurytomidae				x		x
Mutillidae					x	
Cynipidae	x		x			
Formicidae	x	x	x		x	x
Pompilidae		x				x
Sphecidae				x		
Halictidae		x				
Apidae						
Apis mellifera		x				x
ACARINA	x	x	x		x	x
Dermacentor variabilis					x	
ARANEIDA	x	x	x	x	x	x

Table 3-13B. Invertebrates collected in four of six sample years from young foredune by Texas Instruments, Cowles Unit.

COLLEMBOLA--springtails
- Entomobryidae

PSOCOPTERA--psocids
- Pseudocaeciliidae

THYSANOPTERA
- Thrypidae--common thrips

HEMIPTERA
- Lygaeidae--seed bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Delphacidae--planthoppers

COLEOPTERA
- Carabidae--ground beetles
- Helodidae--marsh beetles
- Coccinellidae--ladybird beetles
- Pedilidae--false ant-like flower beetles
- Scarabaeidae--scarab beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles

NEUROPTERA
- Myrmeliontidae--antlions

LEPIDOPTERA
- Papilionidae--swallowtails
- Pieridae--whites/sulfurs
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chironomidae--midges
- Culcidae--mosquitoes
- Asilidae--robber flies
- Dolichopodidae--long-legged flies
- Pipunculidae--big-headed flies
- Calliphoridae--blow flies
- Muscidae--muscid flies

HYMENOPTERA
- Ichneumonidae--ichneumon wasps
- Formicidae--ants

ACARINA--mites

ARANEIDA--spiders

Table 3-13C. Trophic levels of invertebrates collected in four of six sample years from young foredune, Cowles Unit.

HERBIVORES
- Lygaeidae--seed bugs
- Cicadellidae--leafhoppers
- Delphacidae--planthoppers
- Pedilidae--false ant-like flower beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles
- Papilionidae--swallowtails
- Pieridae--whites/sulfurs
- Micromoths

PREDATORS
- Carabidae--ground beetles
- Coccinellidae--ladybird beetles
- Myrmeliontidae--antlions
- Asilidae--robber flies
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Entomobryidae--springtails
- Pseudocaeciliidae--psocids
- Chironomidae--midges
- Calliphoridae--blow flies

PARASITES
- Ichneumonidae--ichneumon wasps

Table 3-14A. Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from old foredune east of Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980), Cowles Unit.

	1974	1975	1976	1977	1978	1979
COLLEMBOLA						
Poduridae			x			x
Isotomidae			x		x	x
Entomobryidae	x		x			x
EPHEMEROPTERA						
Baetidae		x				
Baetis sp.						x
Chloeon sp.					x	x
ODONATA						
Aeschnidae	x	x				
Libellulidae	x	x				x
Leucorrhina intacta			x			
Erythemis sp.					x	
Plathemis lydia		x	x			x
Sympetrum vicinium					x	
Perithemis tenera		x				
Coenagrionidae	x	x			x	
Amphiagrion caucium			x			
Enallagma sp.		x	x	x	x	x
Ischnura sp.				x		x
ORTHOPTERA						
Acrididae	x	x	x		x	
Melanoplus sp.		x				
Tetigoniidae	x	x	x		x	
Microcentrum sp.						x
Neoconocephalus sp.						x
Gryllidae	x	x				
Oecanthus sp.	x			x		
Phasmatidae	x	x				
Diapheromera femorata				x		
Mantidae		x		x	x	
Blattidae		x				
Parcoblatta virginica					x	
ISOPTERA						
Rhinotermitidae					x	
PLECOPTERA						
Perlidae						
Perlesta placida					x	
PSOCOPTERA						
Liposcelidae	x					
Psocidae					x	
THYSANOPTERA						
Phloeothripidae	x					
HEMIPTERA						
Corixidae	x	x				
Sigara sp.			x		x	x
Trichocorixa sp.					x	
Notonectidae		x				
Notonecta sp.	x		x		x	x

Table 3-14A continued

HEMIPTERA-Cont.	1974	1975	1976	1977	1978	1979
Pleidae						
Plea sp.		x				
Plea striola					x	
Belostomatidae						
Belostoma sp.			x			x
Gerridae		x				
Gerris sp.			x			x
Trepobates sp.					x	
Veliidae		x				
Mesoveliidae						
Mesovelia sp.					x	
Nepidae						
Nepa apiculata	x					
Ranatra sp.			x			
Hebridae		x				
Miridae	x	x				
Adelphocoris lineotatus						x
Lygus lineolaris	x		x			
Plagiognathus obscurus			x			
Trigonotylus ruficornis			x			
Gelastocoridae	x			x		
Nabidae	x					
Reduviidae	x	x				
Phymatidae	x					
Phymata sp.			x			
Tingidae						
Corythuca contracta			x			
C. marmorata				x		x
Lygaeidae	x	x				
Lygaeus kalmii				x		
Nysius sp.						x
Orthea sp.				x		
Coreidae	x					x
Pentatomidae	x					
Cydnidae	x					
Membracidae						
Ceresa bubalus			x			
Enchenopa binotata			x			
Cyrtolobus sp.					x	x
Ophiderma sp.					x	
Telamona sp.						x
Vanduzea sp.			x			
Cicadellidae	x	x	x			x
Agallia constricta	x					x
Chlorotettix sp.					x	
Cloanthanus sp.						x
Commellus sp.					x	
Draeculacephala sp.				x		
Empoasca sp.					x	x
Erythroneura sp.					x	
Flexamia sp.					x	
Graphocephala sp.					x	x
Gyponana sp.				x	x	
Limotettix sp.				x		
Macrosteles divisa					x	x
M. fascifrons			x			

Table 3-14A continued

	1974	1975	1976	1977	1978	1979
HOMOPTERA						
Cicadellidae						
Paraphlepsius sp.					x	
Polyamia sp.					x	x
Cercopidae	x	x	x	x	x	x
Delphacidae		x	x		x	x
Cixiidae		x			x	
Achilidae					x	
Flatidae						x
Acanaloniidae				x	x	x
Issidae	x	x				
Psyllidae		x	x	x		
Aphididae	x	x	x		x	x
COLEOPTERA						
Cicindelidae						
Cicindela hirticollis			x			
Carabidae						
Bembidion sp.		x				
Lebia viridis			x			
Platynus sp.						x
Tachys sp.						x
Haliplidae						
Haliplus sp.			x			
Paltodytes sp.	x	x				
P. muticus			x			
Dytiscidae	x					
Hydroporus sp.			x			
Laccophilus sp.	x	x	x			x
Gyrinidae						
Gyrinus borealis			x			
Hydrophilidae						
Berosus sp.	x	x				
Enochrus sp.	x					
Helophrus sp.	x					
Hydrochara obtusata					x	
Tropisternus sp.	x	x			x	x
T. lateralis			x			
Staphylinidae	x				x	
Stenus sp.		x				
Cantharidae		x				
Podabrus sp.	x	x				
Lampyridae						
Photinus sp.		x			x	
Otractibena			x			
Malachiidae						
Attalus sp.		x				
A. terminalis				x		x
Cleridae	x					
Phyllobaenus pallipennis						x
Phalacridae		x				
Phalacrus sp.						x
Elateridae			x			
Athous sp.			x			
Melanotus sp.						x

Table 3-14A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-Cont.						
Buprestidae						
Acmaeodera pulchella			x		x	
Brachys ovatus		x				
Helodidae						
Cyphon sp.	x				x	
Scrites	x				x	
Cryptophagidae	x					
Nitidulidae	x					
Erotylidae						
Megalodacne fasciata					x	
Coccinellidae						
Chilocoris stigma		x				
Coleomegilla fuscilabris	x					x
Cycloneda munda	x					
Hippodamia convergens	x					
H. 13-punctata					x	
Anthicidae						
Anthicus sp.	x					
Notoxus sp.					x	
Pedilidae					x	
Macratia sp.	x	x				
Mordellidae						
Mordella sp.		x	x		x	x
Mordellistena sp.	x		x			x
Alleculidae						
Hymenorus sp.					x	
Isomira sericea			x		x	
Tenebrionidae						
Uloma imberbis					x	
Xylopinus saperdioidea					x	
Melandryidae	x					
Symphora		x			x	
Anobiidae	x					
Scarabaeidae						
Anomala sp.			x			
Ataenius sp.	x				x	
Phyllophaga sp.	x	x	x		x	
Serica sp.	x					
Cerambycidae						
Psenocerus supernotatus					x	
Saperda vestita		x				
Chrysomelidae		x				
Anisostena sp.			x			
Calligrapha sp.	x					
Cerotoma trifurcata	x					
Chaetocnema minuta	x	x				x
Colaspis sp.					x	
Crepidodera sp.		x				
Criocerus 12-punctata	x					
Cryptocephalus sp.			x			
Diachus sp.					x	
Diabrotica 12-punctata	x					
D. virgifera				x		
Disonychia sp.					x	
Lema collaris			x		x	

Table 3-14A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA, Chrysomelidae--Cont.						
Longitarsus sp.			x			
Oedionychus sp.						x
Pachybrachis sp.			x	x		x
Trirhabda virgata						x
Tymnes sp.			x			
Anthribidae		x				
Curculionidae	x	x	x		x	x
NEUROPTERA						
Chrysopidae	x	x			x	x
Hemerobiidae	x					x
Myrmeliontidae		x	x	x	x	
TRICHOPTERA						
Hydropsychidae						
Hydropsyche sp.						x
Leptoceridae	x					
Athripsodes				x	x	
Limnephilidae	x					
LEPIDOPTERA						
Papilionidae						
Palilio glaucus	x					x
P. polyxenes		x			x	x
Pieridae						
Colias philodice	x	x			x	
Pieris rapae	x	x	x		x	
P. protodice				x		
Danaidae						
Danaus plexippus	x	x			x	
Nymphalidae						
Euphydras phaeton						x
Junonia coenia		x	x	x		
Limenetis archippus		x	x			x
Phyciodes tharos			x			x
Speyeria cybele				x	x	
Satyridae						
Lethe eurydice						x
Lycaenidae						
Everes comyntas		x				
Lycaenopsis argiolus		x				
Hesperiidae						x
Arctiidae						
Halisodota tesselaris			x		x	x
Hypo prepia fucosa				x		
Noctuidae	x		x			
Geometridae	x	x				
Bapta vestaliata			x			
Tetracis crocallata					x	
Notodontidae						
Datana ministra	x					
Pyralidae		x				
Tortricidae			x			
Micromoths		x	x	x	x	x

Table 3-14A continued

	1974	1975	1976	1977	1978	1979
DIPTERA						
Tipulidae	x	x			x	x
Ptychopteridae						
Bittacomorpha clavipes	x					
Ptychoptera sp.	x					
Psychodidae		x			x	
Chaoboridae	x					x
Chironomidae	x	x	x	x	x	x
Simuliidae	x	x				
Culicidae	x	x	x		x	x
Mycetophilidae				x		
Sciaridae	x	x			x	x
Cecidomyiidae	x	x		x	x	
Ceratopogonidae	x	x	x		x	
Stratiomyiidae	x	x		x	x	x
Tabanidae						
Chrysops sp.		x				
C. cincticornis			x			
C. vittatus				x		
Threvidae	x	x				
Scenopinidae	x					
Metatrichia			x			
Mydidae						
Mydas clavatus						x
Bombyliidae			x			x
Lonchopteridae						
Lonchoptera sp.	x	x				
Empididae		x		x		
Chelipoda sp.					x	
Hybos sp.					x	
Dolichopodidae	x	x				
Argyra sp.					x	
Chrysotus sp.				x	x	
Condylostylus sp.				x		
Dolichopus sp.				x	x	x
Sciaphus sp.					x	
Pipunculidae	x	x				
Rhagionidae				x		
Syrphidae	x	x	x			x
Tephritidae	x					
Sepsidae		x				
Lauxaniidae	x					
Camptoprosopella sp.					x	
Minettia sp.			x			
Sapromyza sp.				x		
Piophilidae	x	x		x	x	x
Sphaeroceridae	x	x	x		x	x
Ephydridae	x	x				
Scatella sp.			x			
Drosophilidae	x	x				x
Chymomyza sp.					x	
Chloropidae	x	x				
Hippelates sp.			x		x	
Oscinella sp.						x

Table 3-14A continued

	1974	1975	1976	1977	1978	1979
DIPTERA-Cont.						
Anthomyiidae	x	x				
Heleomyzidae		x				
Clusiidae		x			x	
Calliphoridae		x				
Lucillia sp.			x			
Muscidae	x	x			x	
Musca domestica				x		x
Tachinidae						x
HYMENOPTERA						
Tenthredinidae		x				
Braconidae	x	x	x	x	x	x
Ichneumonidae	x		x	x	x	
Torymidae	x					
Pteromalidae		x	x			
Eurytomidae						x
Evaniidae			x			
Prototrupidae			x			
Chalcididae		x				
Cynipidae	x		x			
Tiphiidae				x		
Formicidae	x	x	x	x	x	x
Sphecidae				x		x
Andrenidae	x					
Halictidae	x	x	x		x	
Apidae						
Apis mellifera	x	x	x	x	x	x
PSEUDOSCORPIONIDA	x		x			
PHALANGIDA			x	x	x	x
ACARINA	x	x	x		x	x
Hydrachnidae		x				
ARANEIDA	x	x	x	x	x	x
AMPHIPODA	x	x			x	x
ISOPODA	x	x	x			x
CLASS CHILOPODA	x					

Table 3-14B. Invertebrates collected in four of six sample years from old foredune by Texas Instruments, Cowles Unit.

ODONATA
- Libellulidae--common skimmers
- Coenagrionidae--narrow-winged damselflies

ORTHOPTERA
- Acrididae--short-horned grasshoppers
- Tetigoniidae--long-horned grasshoppers

HEMIPTERA
- Corixidae--water boatmen
- Notonectidae--backswimmers
- Gerridae--water striders
- Miridae--plant bugs
- Lygaeidae--seed bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Delphacidae--planthoppers
- Aphididae--plantlice

COLEOPTERA
- Dytiscidae--predaceous diving beetles
- Hydrophilidae--water scavenger beetles
- Mordellidae--tumbling flower beetles
- Scarabaeidae--scarab beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles

NEUROPTERA
- Chrysopidae--common lacewings
- Myrmeliontidae--antlions

LEPIDOPTERA
- Papilionidae--swallowtails
- Pieridae--whites/sulfurs
- Nymphalidae--brush-footed butterflies
- Arctiidae--tiger moths
- Geometridae--measuringworms
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chironomidae--midges
- Culicidae--mosquitoes
- Sciaridae--dark-winged fungus gnats
- Cecidomyiidae--gall gnats
- Ceratopogonidae--biting midges
- Stratiomyidae--soldier flies
- Dolichopodidae--long-legged flies
- Syrphidae--flower flies
- Lauxaniidae--lauxaniids
- Piophilidae--skipper flies
- Sphaeroceridae--small dung flies
- Drosophilidae--small fruit flies
- Chloropidae--fruit flies
- Muscidae--muscid flies

HYMENOPTERA
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps
- Formicidae--ants
- Halictidae--carpenter bees
- Apidae--fumble/honey bees

PHALANGIDA--daddy-long-legs

ACARINA--mites

ARANEIDA--spiders

AMPHIPODA--scuds

ISOPODA--sow bugs

Table 3-14C. Trophic levels of invertebrates collected in four of six sample years from old foredune, Cowles Unit.

HERBIVORES
- Acrididae--short-horned grasshoppers
- Tetigoniidae--long-horned grasshoppers
- Miridae--plant bugs
- Lygaeidae--seed bugs
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Delphacidae--planthoppers
- Aphididae--plantlice
- Mordellidae--tumbling flower beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles
- Papilionidae--swallowtails
- Pieridae--whites/sulfurs
- Nymphalidae--brush-footed butterflies
- Arctiidae--tiger moths
- Geometridae--measuringworms
- Micromoths
- Apidae--bumble/honey bees

PREDATORS
- Libellulidae--common skimmers
- Coenagrionidae--narrow-winged damselflies
- Notonectidae--backswimmers
- Gerridae--water striders
- Dytiscidae--predaceous diving beetles
- Chrysopidae--common lacewings
- Myrmeliontidae--antlions
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Hydrophilidae--water scavenger beetles
- Chironomidae--midges
- Lauxaniidae--lauxaniids
- Piophilidae--skipper flies
- Sphaeroceridae--small dung flies
- Amphipoda--scuds
- Isopoda--sow bugs

PARASITES
- Ceratopogonidae--biting midges
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps

genera in the family or different families in the order (e.g., Scarabaeidae, Acarina) are different so that the family (or order or class) cannot be listed in a single category; we shall not list them in any category. Following these criteria the families in the simplified lists are placed into trophic levels in Tables 3-13C and 3-14C.

Not surprisingly it is the plant feeders which are represented by the largest number of families in both lists. The predators, which are dependent upon these herbivores, are represented by fewer families. There is a fair number of scavenger families in both cases; most of those found in the young foredune collections are usually found in litter, but this is not true of the families taken in the old foredune collections. There is a single family of parasites represented in the young foredune collections, three in the old foredune collections. All in all there are more families in each trophic level in collections from the old foredune than present in collections from the young foredune. As a matter of fact, the total number of families in the old foredune collections (157) is the largest of all the community types considered in this study. In their report the Texas Instruments group notes that they collected not only from the foredune proper but also from a marshy area and a pool of standing water within the foredune caused by runoff from atop the dune being diverted through a pipe to the foredune area. Included in their list, therefore, and adding considerably to its size, are a number of aquatic forms (e.g., Libellulidae, Coenagrionidae, Corixidae, Notonectidae, Gerridae, Dytiscidae, Hydrophilidae, and Amphipoda) one would not ordinarily find in the foredune community.

Another point of interest is regarding the completeness of the samples as evaluated by how many new families are added in samples taken in successive years. In the young foredune community 80 families were represented in the 1974 collections; 24 were added in 1974, this increment constituting 23.1% of the total of 104 families. These values in the following years were:

7	families,	6.3%	of total of	111,	added in	1976;
4	"	3.5%	"	115	"	1977;
9	"	7.3%	"	124	"	1978;
7	"	5.3%	"	131	"	1979.

The comparable values for the old foredune community are as follows:

93	families collected in 1974;					
32	families,	25.6%	of total of	125,	added in	1975;
14	"	10.1%	"	139	"	1976;
4	"	2.8%	"	143	"	1977;
7	"	4.7%	"	150	"	1978;
7	"	4.5%	"	157	"	1979.

In both cases it can be seen that about one-fourth of the families in the second year's collections were new ones. The number of new families added in subsequent years, however, was relatively small, on the order of 5%. Continued sampling can be expected to add even smaller numbers percentage-wise.

For purposes of evaluating the completeness of the single collection of each sort we made in the several communities we sampled in 1980 the following should be noted. The Texas Instrument samples in 1974 and 1975 represent several collections during the course of those years. Since we are interested in determining the adequacy of a single collection in a given year we should use the 1976 data as a baseline. When this is done the following values are obtained. In the young foredune community

46 families were collected in 1976;
13 families, 22.0% of total of 59, were added in 1977;
19 " 24.4% " 78 " 1978;
11 " 12.4% " 89 " 1979.

In the old foredune community

69 families were collected in 1976;
18 families, 20.7% of total of 87, were added in 1977;
28 " 24.3% " 115 " 1978;
11 " 8.7% " 126 " 1979.

From these data it can be seen that collections at one time in a given year, such as we were able to make, are not an adequate sample. Nearly as many families as taken in the first collection can be expected to be added in single collections over the next three years.

Blowout complexes -- The foredunes just described are not continuous along the shoreline of the lake. Responsible for breaks in the foredunes, for one thing, is wave erosion; this was referred to above and will be considered in further detail below. Wind erosion is another factor of great importance. From time to time wind breaches the developing or developed foredunes, and even the higher dunes which typically succeed them. A small channel of open sand in the dune may focus wind currents and/or be enlarged so as to form an extensive area of unstable sand devoid of vegetation. Such active areas, called blowouts, are the bare sand areas coded A-2 on the land use maps. Because the strongest winds are from the northwest they tend to extend in a southeasterly direction, though landforms may direct the winds in such a way that another direction is followed. The open sand of blowouts is exposed to winds of great velocity and the sand which accumulates at the leeward end of the blowout may extend several feet per year over previously established communities. In general blowout activity regularly results in dunes moving over previously formed ones and in the process the formation of dunes considerably higher and more irregular in orientation than those along the beach.

Though the bowl of the blowout is generally devoid of plants, vegetation does develop along the margins, in patches along the crest, and sometimes on the leeward slope. The grasses, herbs, and shrubs characteristic of the foredunes are commonly established in these areas. But they are regularly accompanied by a number of vines whose seeds are readily distributed by birds: wild grape, bittersweet, and poison ivy. Those areas coded B-2 (grass--intermittent cover) are of this sort. Adjoining most of these areas are ones coded F-1 (woodland--continuous crown). Often in the immediate vicinity of the B-2 areas there are trees in the adjoining F-1 areas which are not otherwise common in them; if so, they are noted and ranked in the B-2 areas. The area coded C in the West Beach section consists of a depression in a blowout complex in which there is a rich mixture of plants surrounding the marsh which has developed in the wet part of the depression.

In addition to the aspects of blowout activity discussed above, those which are most readily noticed, there is another aspect which is very important in that it provides for additional variation in habitat types in the dunes region. The wind action described above often scours the sand at the lakeward side of the dune to a depth which is near or below the water table. When foredunes subsequently develop parallel to the shoreline, depressional pockets are formed between the face of the blowout and the rear of the foredune. Several habitat types are thus formed, which one depending on the relationship between the floor of the depression and the water table. If the floor lies well above the water table there is little difference from other open sand of the blowout. If the floor lies just above the water table the substrate will be moist and much more stable than adjacent sand, thus capable of supporting a different kind of vegetation than the adjoining dunes; these habitats are referred to as "pannes." If the floor lies just below the water table conditions are suitable for the development of marshy vegetation. If the floor lies well below the water table an intradunal pond develops.

Blowout complexes have, therefore, aquatic and wetland communities in addition to terrestrial ones. As this chapter is organized, the aquatic and wetland communities will be treated in later sections. Here we shall consider only the terrestrial communities, including the pannes.

There are the following major blowout complexes along the national lakeshore shoreline: 1) that associated with Mount Baldy in the East Unit; 2) that at the north end of Central Avenue in the East Unit; 3) that at the north end of Kemil Road in the East Unit; 4) that west of Dune Acres in the Cowles Unit; 5) that east of Ogden Dunes in the West Unit; 6) that west of Ogden Dunes in the West Unit; 7) that east of United States Steel in the West Unit.

The sand of Mount Baldy in the East Unit itself is moving to the extent that there is very little, if any vegetation on either the windward or leeward slopes. Near the crest there are a few scattered clumps of marram grass (Ammophila breviligulata), sand reedgrass (Calamovilfa longifolia), and early goldenrod (Solidago juncea). On the western flank of Mount Baldy is a dune much smaller than and not nearly as high as Mount Baldy on which there is considerable vegetation. This vegetation is ranked in Table 3-15. The high rankings of sand reedgrass and little

in this community support the judgment based on the amount of cover as compared to open sand that this dune is rather well stabilized.

To the east of Mount Baldy, at the east end of the East Unit, is a dune referred to locally as "Crescent Dune" which may be considered as part of the Mount Baldy complex. It lies behind a steel bulkhead placed there to protect the shoreline. A large expanse of open sand extends to the east and south. The vegetation adjoining the open sand

Table 3-15. Stratum ranks of plant species on dune adjoining Mount Baldy to the west--NE¼ NE¼ NE¼, section 36, T 38 N, R 5 W, East Unit.

Morus rubra red mulberry	1	Trees
Salix spp. willow shrubs	4	Shrubs
Cornus stolonifera red-osier dogwood	4	
Vitis sp. wild grape	4	
Calamovilfa longifolia sand reedgrass	8	Herbs
Andropogon scoparius little bluestem	6	
Artemisia caudata wormwood	5	
Solidago racemosa gillimani dune goldenrod	5	
Lithospermum caroliniense hairy puccoon	4	
Monarda punctata villicaulis horsemint	4	
Ammophila breviligulata marram grass	3	
Asclepias syriaca common milkweed	3	
Elymus canadensis nodding wild rye	3	
Asclepias tuberosa butterfly-weed	2	
Asclepias verticillata whorled milkweed	2	
Cakile edentula lacustris sea-rocket	2	
Cyperus schweinitzii Schweinitz' umbrella-sedge	2	
Cyperus tenuifolius thin-leaved umbrella-sedge	2	
Oenothera biennis evening-primrose	2	
Panicum meridionale mat panic-grass	2	
Saponaria officinalis soapwort	2	

is sparse and dominated by marram grass. The remainder of the dune is rather densely covered with the vegetation ranked in Table 3-16. The high ranking of marram grass and the presence of other foredune plants, particularly to the south and east, are indicative of continued sand movement in that portion of the dune. The western portion of the dune, however, where there is considerable sand reedgrass among the marram grass, seems considerably more stable.

Table 3-16. Stratum ranks of vegetation of Crescent Dune-- SE¼ NW¼ SE¼, section 30, T 38 N, R 4 W, East Unit.

Vitis sp. wild grape	7	Shrubs
Cornus stolonifera red-osier dogwood	4	
Parthenocissus quinquefolia Virginia creeper	4	
Morus rubra red mulberry	3	
Salix sp. willow	3	
Ptelea trifoliata hoptree	3	
Rhus radicans poison-ivy	3	
Populus deltoides cottonwood	2	
Prunus pumila sand cherry	2	
Ammophila breviligulata marram grass	7	Herbs 5 July 78
Calamovilfa longifolia sand reedgrass	5	
Artemisia caudata wormwood	4	
Saponaria officinalis soapwort	4	
Antennaria sp. pussytoes	3	
Asclepias syriaca common milkweed	3	
Cakile edentula lacustris sea-rocket	3	
Corispermum hyssopifolium bugseed	3	
Equisetum hyemale affine common scouring-rush	3	
Tradescantia ohiensis common spiderwort	3	
Oenothera biennis evening-primrose	2	
Solidago juncea early goldenrod	4	22 Sept. 79
Helianthus petiolaris prairie sunflower	3	
Cyperus schweinitzii Schweinitz' umbrella-sedge	2	
Euphorbia polygonifolia seaside spurge	2	
Solidago racemosa gillmani dune goldenrod	2	

Just west of Central Avenue in the East Unit as it ends at the lake is a blowout complex. The vegetation of the dunes which make up this complex is ranked in Table 3-17. That sand reedgrass and little bluestem are ranked higher than marram grass, and that cottonwood and sand cherry are of considerable importance, indicate that this blowout has been stabilized for some time.

The plants established within and along the margins of the blowout to the east of Kemil Road where it joins Lakeshore Drive are ranked in Table 3-18. Though there is a great deal of diversity in this community and sand cherry has a rather high rank, the fact that marram grass is equal in importance to sand reedgrass and little bluestem indicates that the sand in certain portions of this blowout at least has not been stabilized.

The plants primarily along the margins and on the crest of the large blowout just west of Dune Acres in the Cowles Unit are ranked in Table 3-19. The presence of a variety of trees and shrubs other than cottonwood and sand cherry, the high ranking of sand reedgrass and little bluestem, and the absence of marram grass indicate that the margins and crest of this blowout have been stabilized for some time.

Just east of Ogden Dunes in the West Unit, behind the foredunes described above, is a blowout complex consisting of a panne and two lobes of healing sand. The vegetation of the panne is ranked in Table 3-20. Immediately apparent is the presence, and in many cases high ranking, of plants which are characteristic of damp substrates: Kalm's St. John's-wort, lakeshore rush, narrowleaf cattail, Kalm lobelia, nodding ladies'-tresses, and rose-pink. These and others on the list are regularly found along the margins of intradunal ponds as described below in the aquatic section. And cattail, of course, is a common marsh plant. Though the substrate is wet, we did not in any season of the year, observe water standing in this depression.

Two lobes of partially vegetated sand extend southward beyond the panne, one to the east of a wooded ridge, one to the west of it. The vegetation of these lobes, obviously of a healing blowout, is ranked in Table 3-21. The abundance of trees and shrubs (including several conifers), the high ranking of little bluestem, and the absence of marram grass indicate that these blowout lobes have been stabilized for some period of time.

The blowout complex west of Ogden Dunes is the West Unit in very extensive and complex. Between the foredune ridges and the older dunes to the south of them are a number of intradunal ponds which are treated in the aquatic section. The older dunes are in some cases active and characterized by open sand (these are coded A-2 on the land use map), though along the stable margins there may be vegetation (predominantly cottonwood, sand cherry, basswood, marram grass, sand reedgrass, and little bluestem). In other cases the older dunes are quite stable and covered with vegetation; these are coded B-2 on the land use map. Parts

Table 3-17. Stratum ranking of plant species on blowout complex west of Central Avenue--NE¼, NE¼, SE¼, section 35, T 38 N, R 5 W.

Populus deltoides cottonwood	4	Trees
Liriodendron tulipifera tuliptree	1	
Prunus pumila sand cherry	4	Shrubs
Salix sp. willow	3	
Ptelea trifoliata hoptree	2	
Calamovilfa longifolia sand reedgrass	8	Herbs
Andropogon scoparius little bluestem	6	
Artemisia caudata wormwood	5	
Solidago racemosa gillmani dune goldenrod	5	
Ammophila breviligulata marram grass	4	
Lithospermum caroliniense hairy puccoon	4	
Monarda punctata villicaulis horsemint	3	
Panicum virgatum switchgrass	3	
Cakile edentula lacustris sea-rocket	2	
Equisetum laevigatum smooth scouring-rush	2	
Panicum meridionale mat panic-grass	2	

Table 3-18. Stratum ranking of plant species on blowout east of Kemil Road--NW¼ NW¼ NW¼, section 9, T 37 N, R 5 W, East Unit.

Populus deltoides cottonwood	4	Trees
Tilia americana basswood	2	
Prunus pumila sand cherry	6	Shrubs
Rhus radicans poison-ivy	3	
Salix sp. willow	3	
Vitis sp. wild grape	3	
Celastrus scandens bittersweet	2	
Juniperus communis depressa ground juniper	2	
Rhus aromatica fragrant sumac	2	
Rosa blanda meadow rose	2	
Rubus sp. rasp- black- berry	2	
Arabis lyrata rockcress	6	Herbs 30 May 74
Lithospermum caroliniense hairy puccoon	4	
Lupinus perennis lupine	4	
Phlox pilosa downy phlox	3	
Potentilla sp. cinquefoil	3	
Lepidium virginicum pepper-grass	2	
Tragopogon dubius larger goat's-beard	2	
Ammophila breviligulata marram grass	6	5 Aug. 75
Andropogon scoparius little bluestem	6	
Calamovilfa longifolia sand reedgrass	6	
Artemisia caudata wormwood	5	
Asclepias syriaca common milkweed	4	
Elymus canadensis nodding wild rye	4	
Equisetum hyemale affine common scouring-rush	3	
Euphorbia corollata flowering spurge	3	
Saponaria officinalis soapwort	3	
Solidago sp. goldenrod	3	
Euphorbia polygonifolia seaside spurge	2	
Monarda punctata villicaulis horsemint	2	
Verbascum thapsus common mullein	2	
Cirsium pitcheri sand thistle	1	

Table 3-19. Stratum ranks of vegetation on blowout just west of Dune Acres--centered at eastern margin of SE¼ NE¼ NE¼, section 21, T 37 N, R 6 W, Cowles Unit.

Populus deltoides cottonwood	5	Trees
Tilia americana basswood	4	
Quercus velutina black oak	3	
Juniperus virginiana creba red cedar	2	
Pinus strobus white pine	2	
Prunus pumila sand cherry	6	Shrubs
Cornus stolonifera red-osier dogwood	5	
Vitis sp. wild grape	5	
Rhus aromatica fragrant sumac	3	
Calamovilfa longifolia sand reedgrass	6	Herbs
Andropogon scoparius little bluestem	6	
Solidago sp. goldenrod	5	
Lithospermum caroliniense hairy puccoon	4	
Asclepias tuberosa butterfly-weed	3	
Tradescantia ohiensis common spiderwort	2	

Table 3-20. Stratum ranks of vegetation of panne just east of Ogden Dunes--at center of N margin of NW¼ NW¼ SW¼, section 25, T 37 N, R 7 W, West Unit.

Populus deltoides cottonwood	3	Trees
Hypericum kalmianum Kalm's St.-John's-wort	6	Shrubs
Salix sp. willow	4	
Cornus stolonifera red-osier dogwood	3	
Pinus banksiana Jack pine	3	
Senecio pauperculus balsam ragwort	2	Herbs 25 May 79 23 Aug. 78
Juncus balticus littoralis lakeshore rush	5	
Typha angustifolia narrowleaf cattail	4	
Erigeron canadensis horseweed	2	
Solidago juncea early goldenrod	6	
Lobelia kalmii Kalm lobelia	4	
Solidago graminifolia grass-leaved goldenrod	4	
Aster ericoides heath aster	3	
Eupatorium perfoliatum common boneset	3	
Gerardia purpurea purple gerardia	3	
Spiranthes cernua nodding ladies'-tresses	2	
Aster novae-angliae New England aster	1	
Perilla frutescens purple perilla	1	
Sabatia angularis rose-pink	1	

Table 3-21. Stratum ranks of vegetation on blowout lobes just east of Odgen Dunes--center of N half NW¼ SW¼, section 25, T 37 N, R 7 W, West Unit.

Populus deltoides cottonwood	5	Trees
Pinus banksiana jack pine	4	
Juniperus virginiana creba red cedar	3	
Cornus stolonifera red-osier dogwood	6	Shrubs
Arctostaphylos uva-ursi coactilis bearberry	5	
Celastrus scandens bittersweet	5	
Vitis sp. wild grape	5	
Juniperus communis depressa ground juniper	3	
Prunus pumila sand cherry	3	
Opuntia compressa prickly-pear	3	
Rhus aromatica fragrant sumac	3	
Rhus radicans poison-ivy	3	
Prunus virginiana choke cherry	2	
Arabis lyrata rockcress	4	Herbs 25 Mar. 79
Lithospermum caroliniense hairy puccoon	4	
Andropogon scoparius little bluestem	7	23 Aug. 78
Calamovilfa longifolia sand reedgrass	3	
Artemisia caudata wormwood	3	
Euphorbia corollata flowering spurge	2	
Solidago juncea early goldenrod	5	21 Sept. 79
Solidago racemosa gillmani dune goldenrod	4	
Aster ericoides heath aster	3	
Cirsium pitcheri sand thistle	3	
Helianthus petiolaris prairie sunflower	2	
Solidago speciosa showy goldenrod	2	

of these dunes are at a relatively low elevation and border the intradunal ponds. The plant species of one such area, that at SW¼ SE¼ SE¼, section 27, T 37 N, R 7 W, are ranked in Table 3-22. The evergreens, jack pine and common juniper, are particularly noticeable in this stand, though they are scattered and are thus ranked 4. Among the herbs it is the grasses of the stable and growing foredunes which are important; and it is because of this that this community is treated here, even though wet substrate plants (such as Kalm's St. John's-wort, Kalm lobelia, and rose-pink) are present, rather than as a community found along the margin of intradunal ponds. A nearby area, in the southern portion of NE¼ SE¼ SE¼, section 27, T 37 N, R 7 W, is entirely at a low elevation and relatively close to the water table. Its vegetation differs only in that the jack pine and cottonwood reach tree size and dominate that stratum with a rank of 6 each. Another stand, coded F-2 and located in the northern portion of SE¼ SE¼ SE¼, section 27, T 37 N, R 7 W, lies within an area coded F-3. Its vegetation is ranked in Table 3-23. The high ranking of jack pine and cottonwood, the high ranking of little bluestem and sand reedgrass, and the absence of marram grass indicate that this portion of the blowout complex has long been stabilized.

We did not ordinarily attempt to list and rank plant species in areas highly modified by man. One area for which an exception was made is the sand-mined area, coded D on the land use map, which lies between the blowout complex of the West Beach and Long Lake in the West Unit. The northern third of this extensive area, which is not too unnatural in appearance and is covered with many of the same plants as the dunes in the blowout complex adjoining it to the north, was included in our study. The plant species of this area are ranked in Table 3-24. It is because of the high rankings of cottonwood, sand cherry, little bluestem, and sand reedgrass--plants of stabilized blowouts--that this community is treated here. On the list, however, will be noted a number of woodland species and introduced species. Since this listing and ranking was done, the West Beach bath house, parking area, and picnic area have been developed. Only the bath house itself is located in the more natural northern third of the sand-mined area, thus a large portion of the community remains.

Between the foredune ridges paralleling the beach east of United States Steel Corporation and the Grand Calumet River in the West Unit are many hills of sand which represent a blowout complex. Coded A-2 on the land use map, parts are completely open and other parts are covered with vegetation. This vegetation is ranked in Table 3-25. Cottonwood is the only tree species, but the trees are widely spaced. Sand cherry is the most important shrub. Marram grass and sand reedgrass share dominance in the herb stratum. The fact that little bluestem is ranked several notches below them suggests that there is still considerable movement of sand in this complex.

Dune-shaping processes -- Two dynamic processes were described above which have a role in shaping the dunes along the national lakeshore: 1) dune building and stabilization; 2) blowout activity and stabilization. If only the first process were involved the shoreline would consist of a series of sand ridges parallel to the beach. Blowout activity is

Table 3-22. Stratum ranks of vegetation on stabilized blowout complex in West Beach area--SW¼ SE¼ SE¼, section 27, T 37 N, R 7 W., West Unit.

Pinus banksiana jack pine	4	Trees
Populus deltoides cottonwood	4	
Juniperus communis depressa ground juniper	4	Shrubs
Prunus pumila sand cherry	4	
Arctostaphylos uva-ursi coactilis bearberry	3	
Hypericum kalmianum Kalm's St.-John's-wort	3	
Salix syrticola dune willow	3	
Salix sp. willow	3	
Vitis sp. wild grape	3	
Andropogon scoparius little bluestem	6	Herbs 24 July 74
Calamovilfa longifolia sand reedgrass	5	
Ammophila breviligulata marram grass	4	
Asclepias syriaca common milkweed	3	
Equisetum laevigatum smooth scouring-rush	3	
Lobelia kalmii Kalm lobelia	3	
Sabatia angularis rose-pink	3	
Solidago sp. goldenrod	3	

Table 3-23. Stratum ranks of vegetation of mature stand on stabilized blowout complex in West Beach area--SE¼ SE¼ SE¼, section 27, T 37 N, R 7 W., West Unit.

Pinus banksiana jack pine	6	Trees
Populus deltoides cottonwood	6	
Rhus radicans poison-ivy	5	Shrubs
Vitis sp. wild grape	5	
Celastrus scandens bittersweet	4	
Rhus aromatica fragrant sumac	4	
Arctostaphylos uva-ursi coactilis bearberry	3	
Hypericum kalmianum Kalm's St.-John's-wort	3	
Parthenocissus quinquefolia Virginia creeper	3	
Ptelea trifoliata hoptree	3	
Andropogon scoparius little bluestem	6	Herbs 24 July 74
Calamovilfa longifolia sand reedgrass	5	
Anemone cylindrica candle anemone	3	
Artemisia caudata wormwood	3	
Asclepias tuberosa butterfly-weed	3	
Aster ptarmicoides upland white aster	3	
Galium sp. bedstraw	3	
Helianthus divaricatus woodland sunflower	3	
Liatris aspera rough blazing-star	3	
Lithospermum caroliniense hairy puccoon	3	
Lobelia kalmii Kalm lobelia	3	
Sabatia angularis rose-pink	3	
Cirsium pitcheri sand thistle	2	

Table 3-24. Stratum ranks of plant species of northern third of sand-mined portion of West Beach area--NE¼ NW¼ NE¼, section 34, T 37 N, R 7 W., West Unit.

Populus deltoides cottonwood	6	Trees
Quercus velutina black oak	5	
Tilia americana basswood	4	
Sassafras albidum sassafras	3	
Fraxinus americana white ash	2	
Rhus radicans poison-ivy	6	Shrubs
Celastrus scandens bittersweet	5	
Prunus pumila sand cherry	5	
Vitis sp. wild grape	5	
Arctostaphylos uva-ursi coactilis bearberry	4	
Opuntia compressa prickly-pear	4	
Parthenocissus quinquefolia Virginia creeper	4	
Prunus virginiana choke cherry	3	
Rhus aromatica fragrant sumac	3	
Rhus glabra smooth sumac	3	
Rosa blanda meadow rose	3	
Arabis lyrata rockcress	5	Herbs 31 May 74
Artemisia caudata wormwood	4	
Euphorbia corollata flowering spurge	4	
Lithospermum caroliniense hairy puccoon	4	
Tradescantia ohiensis common spiderwort	4	
Bromus tectorum brome grass	3	
Equisetum hyemale affine common scouring-rush	3	

Table 3-24 continued

Tragopogon dubius larger goat's-beard	3	
Lepidium virginicum pepper-grass	2	
Linaria vulgaris butter-and-eggs	2	
Lupinus perennis lupine	2	
Panicum villosissimum pseudopubescens white-haired panic-grass	2	
Polygonatum sp. Solomon's-seal	2	
Andropogon scoparius little bluestem	6	15 Aug. 74
Calamovilfa longifolia sand reedgrass	5	
Pteridium aquilinum latiusculum bracken fern	4	
Aster sp. aster	3	
Elymus canadensis nodding wild rye	3	
Liatris aspera rough blazing-star	3	
Liatris cylindracea cylindric blazing-star	3	
Solidago sp. goldenrod	3	

Table 3-25. Stratum ranking of plant species on blowout complex east of United States Steel--center of N margin of NW¼ NW¼, section 31, T 37 N, R 7 W., West Unit.

Populus deltoides cottonwood	6	Trees
Prunus pumila sand cherry	5	Shrubs
Vitis sp. wild grape	4	
Celastrus scandens bittersweet	3	
Ammophila breviligulata marram grass	6	Herbs
Calamovilfa longifolia sand reedgrass	6	
Andropogon scoparius little bluestem	4	
Artemisia caudata wormwood	4	
Solidago sp. goldenrod	4	
Asclepias syriaca common milkweed	3	
Corispermum hyssopifolium bugseed	3	
Elymus canadensis nodding wild rye	3	

responsible for the complex pattern of dunes that actually exists; basins are created, dunes are piled up on top of one another, dunes are oriented in directions other than parallel to the beach, etc. But in both cases there is eventually a stabilization. And the stabilized sand of the older foredunes and along the margins of the blowouts, sand with considerable organic matter mixed in it, forms a substrate suitable for the growth of trees other than cottonwood. Notable among these trees are jack pine and black oak, and once they have become established a new community type develops. Often a community dominated by jack pine is the first to develop on the stabilized dunes or blowout margins; black oaks regularly become established in such communities, however, and eventually become the dominant trees. It is possible also for the black oak dominant trees. It is possible also for the black oak dominated community to develop without an intervening jack pine stage on the stabilized dunes or blowout margins. In any case, the black oak community is a stable and long-lived community and very extensive areas of dunes are covered with variants of this type of community. Jack pine and black oak communities will be described below. But before doing that, it will be well to consider still another set of factors that are very important in shaping the dunes along the national lakeshore, namely shoreline erosion and related processes.

As described above in the foredune section, the sand-binding marram grass tends to extend from the foredune onto the open beach, and as it does sothe foredune tends to extend lakeward. Obviously there is a zone of tension between the water of Lake Michigan (plus the ice and snow which accumulate along the shoreline in winter) and the encroaching foredune. A low foredune which may be built up during a mild spell can be quickly eroded away during a heavy storm or by winter ice. Hence, it is quite common for a foredune to have a rather steep front face, a wave-cut cliff, several feet in height.

The fact that the lake level is not constant, but has cycles of high and low levels, obviously has an effect. If the lake level is receding the foredunes can move lakeward and cover a broad expense. But if the lake level is rising, there is extensive erosion of the foredunes. With the rise in lake level which occurred in the early 1970s many of the young foredunes along the national lakeshore were eroded away. At that time, for example, along the western stretch of Lake Shore Drive old foredunes with wave-cut cliffs 20 feet or more in height were the youngest ridges behind the beach.

But the situation is even more complex than that. For various reasons, as the lake level rises erosion is focused more in some areas than others. In such places, notably to the east of Central Avenue in the East Unit, even the older foredunes have been eroded away. Here communities dominated by black oak are those closest to the beach, and they are perched high, in some cases more than 100 feet, above the beach. The open face of sand toward the lake, lacking the roots of vegetation to hold it in place, regularly slumps downward to the lake, and when the substrate slumps away from below them, trees and other plants perched

above break loose from their mooring and slide downward to the lake with the sand. This process will continue, even without further lake erosion, until the sand achieves a stable angle of repose.

Cycles of high lake level and erosion have occurred many times in the past, and undoubtedly at times erosion has cut away the foredunes and into the base of old dunes which were raised to their height by blowout activity. When lake levels receded the cut face slumped until achieving a stable angle of repose or being stabilized by invading grasses. Just as along the beach and at the margins of blowouts, there was probably a succession of plant communities, beginning with the sandblinding marram grass and its associates, extending through the older foredune community type, and continuing into the black oak community. It is likely that such processes are responsible for the fact that in many places along the national lakeshore shoreline (notably immediately east of Kemil Road) there are very high and very steep north-facing dune slopes covered with black oak dominated communities.

Pine dunes -- A well-developed pine dune in the national lakeshore lies in the Cowles Unit just east of the Bailly generating station, at SW¼ SE¼ NW¼, section 21, T 37 N, R 6 W. Its vegetation is ranked in Table 3-26. Though jack pine is by far the most important tree species, other evergreens (white pine, red cedar, and common juniper) are also present; note also the presence of black oak. Little bluestem and sand reedgrass continue to be important plants in the herb stratum.

Along the western margin of the large blowout just west of Dune Acres (Cowles Unit) is a pocket of pine in an otherwise black oak dominated dune complex. The plants of this community are ranked in Table 3-27. In this particular stand basswood is quite important (SR 6), and sand reedgrass is the most important herbaceous species.

Another pine dune forms a tongue between the two sandy lobes of the blowout complex east of Ogden Dunes (West Unit). The vegetation of this dune is ranked in Table 3-28. Jack pine is again the dominant tree, but red cedar and ground juniper are also important evergreens. No grasses are present in this community, which probably means that this is the most mature of these three pine dominated stands. The low number of species in the herb stratum is striking.

Black oak forests on relatively young substrates -- Black oak dominated communities are very extensive and very variable in the dunes region. Some are developed on recently formed dunes, others on dunes formed along ancient beaches; some are in areas of little relief, others in areas where there are distinct ridges/hillocks and depressions; some have closed canopies, others have an open canopy and prairie type ground cover; etc. We shall consider a number of black oak dominated stands, generally proceeding from those in the western portions of the national lakeshore to those in the eastern portion; in so doing we shall, by virtue of which shorelines are represented from west to east, begin with stands developed on substrates of most recent origin and conclude with those developed on substrates of Tolleston age.

Table 3-26. Stratum ranks of vegetation of pine dune east of Bailly generating station--SW¼ SE¼ NW¼, section 21, T 37 N, R 6 W., Cowles Unit.

Pinus banksiana jack pine	7	Trees
Tilia americana basswood	4	
Pinus strobus white pine	3	
Quercus velutina black oak	3	
Juniperus virginiana creba red cedar	2	
Amelanchier sp. serviceberry	1	
Celastrus scandens bittersweet	4	Shrubs
Cornus stolonifera red-osier dogwood	4	
Juniperus communis depressa ground juniper	4	
Prunus virginiana choke cherry	4	
Vitis sp. wild grape	4	
Hamamelis virginiana witch-hazel	3	
Arctostaphylos uva-ursi coactilis bearberry	3	
Parthenocissus quinquefolia Virginia creeper	3	
Ptelea trifoliata hoptree	3	
Rhus aromatica fragrant sumac	3	
Rhus radicans poison-ivy	3	
Rosa blanda meadow rose	2	
Andropogon scoparius little bluestem	4	Herbs
Calamovilfa longifolia sand reedgrass	4	
Solidago sp. goldenrod	4	
Campanula rotundifolia harebell	3	
Helianthus divaricatus woodland sunflower	3	
Liatris aspera rough blazing-star	3	
Maianthemum canadense false lily-of-the-valley	3	
Smilacina racemosa false Solomon's-seal	3	
Artemisia caudata wormwood	2	
Lithospermum caroliniense hairy puccoon	2	
Monarda punctata villicaulis horsemint	2	
Rudbeckia hirta black-eyed Susan	2	
Prenanthes sp. rattlesnake-root	1	

Table 3-27. Stratum ranks of plant species along western margin of blowout just west of Dune Acres--SE¼ NE¼ NE¼, section 21, T 37 N, R 6 W., Cowles Unit.

Pinus banksiana jack pine	6	Trees
Tilia americana basswood	6	
Juniperus virginiana creba red cedar	4	
Pinus strobus white pine	4	
Quercus velutina black oak	4	
Cornus stolonifera red-osier dogwood	4	Shrubs
Prunus virginiana choke cherry	4	
Celastrus scandens bittersweet	3	
Hamamelis virginiana witch-hazel	3	
Parthenocissus quinquefolia Virginia creeper	3	
Ptelea trifoliata hoptree	3	
Rhus radicans poison-ivy	3	
Rosa blanda meadow rose	3	
Calamovilfa longifolia sand reedgrass	5	Herbs
Solidago sp. goldenrod	4	
Campanula rotundifolia harebell	3	
Rudbeckia hirta black-eyed Susan	3	
Smilacina stellata starry false Soloman's-seal	2	

Table 3-28. Stratum ranks of vegetation of pine dune east of Odgen Dunes--SE¼ NW¼ SW¼, section 25, T 37 N, R 7 W., West Unit.

Pinus banksiana jack pine	7	Trees	
Juniperus virginiana creba red cedar	4		
Tilia americana basswood	3		
Pinus strobus white pine	2		
Juniperus communis depressa ground juniper	5	Shrubs	
Parthenocissus quinquefolia Virginia creeper	4		
Vitis sp. wild grape	4		
Cornus stolonifera red-osier dogwood	3		
Fraxinus americana white ash	3		
Ptelea trifoliata hoptree	3		
Prunus virginiana choke cherry	3		
Rhus radicans poison-ivy	3		
Rosa blanda meadow rose	2		
Maianthemum canadense false lily-of-the-valley	7	Herbs	23 Aug. 78
Smilacina stellata starry false Solomon's-seal	4		
Fragaria virginiana strawberry	3		
Solidago caesia blue-stemmed goldenrod	3		21 Sept. 79

Probably the youngest black oak community examined is that just west of Ogden Dunes at NE¼ NE¼ NE¼, section 34, T 37 N, R 7 W in the West Unit. This stand lies along the margin of a blowout complex of recent age, and fresh sand continues to be blown into it. The stand has an unusually dense canopy. Its vegetation is ranked in Table 3-29. Black oak has a very high rank (SR 8). The other tree species, particularly the basswood, are found predominantly at the edge of the stand where sand is accumulating.

Table 3-29. Stratum ranks of plant species of a forest stand along the margin of the West Beach blowout complex--NE¼ NE¼ NE¼, section 34, T 37 N, R 7 W., West Unit.

Quercus velutina black oak	8	Trees
Tilia americana basswood	4	
Sassafras albidum sassafras	3	
Fraxinus americana white ash	2	
Vitis sp. wild grape	5	Shrubs
Parthenocissus quinquefolia Virginia creeper	4	
Prunus virginiana choke cherry	4	
Rhus radicans poison-ivy	4	
Rosa blanda meadow rose	4	
Celastrus scandens bittersweet	3	
Hamamelis virginiana witch-hazel	3	
Ptelea trifoliata hoptree	3	
Rhus aromatica fragrant sumac	3	
Smilax lasioneura carrion-flower	3	
Smilax sp. greenbrier	3	
Ribes sp. currant	1	
Smilacina stellata starry false Solomon's-seal	4	Herbs 29 July 74
Aquilegia canadensis columbine	3	
Euphorbia corollata flowering spurge	3	
Geranium maculatum wild geranium	3	
Helianthus divaricatus woodland sunflower	3	
Pteridium aquilinum latiusculum bracken fern	3	
Asclepias tuberosa butterfly-weed	2	
Aster ptarmicoides upland white aster	2	
Lithospermum caroliniense hairy puccoon	2	
Monarda fistulosa wild bergamot	2	
Polygonatum sp. Solomon's-seal	2	

The remaining black oak communities to be considered are not only older in age but also much more extensive and complex. The complexity lies largely in the fact that as the dunes were formed by the kinds of processes described above--some as ridges roughly parallel to the shoreline, others as hummocks, and still others as crescents--depressions were also created. And as many of these depressions lie near or below the water table, aquatic and wetland habitats exist within the black oak communities. Extensive wetland communities and aquatic communities are treated in later sections of this chapter. Less extensive wetland communities, however, are occasionally treated in the context of the black oak stands in which they lie.

One extensive stand, located at the very western portion of the West Unit south of the Grand Calumet River, is locally referred to as Miller Woods. It is developed on substrates of post-Nipissing-Algoma age. These substrates are primarily beach sand and dune sand, but there are pockets of muck and peat in the depressions where aquatic and marsh communities exist. South of the Indiana Harbor Belt tracks a sequence of sand ridges and intervening depressions extend roughly parallel to the lake; this is referred to as swell and swale topography. The vegetation of the upland portion of this part of the West Unit is ranked in Table 3-30. Almost a hundred plant species were recognized by us in this area, but only two species of mature trees were found. Black oak is the most important (SR 8) by far. Other tree species were recognized but they were of shrub size. Poison ivy is the most important plant in the shrub stratum. Among the herbs columbine is striking in its importance in the spring aspect; the other spring species which is noteworthy is Indian paintbrush, for nowhere else in Indiana have we seen this species in such abundance.

A belt of land between the Indiana Harbor Belt and Amtrak tracks extends eastward from Miller Woods. Substrates in this corridor, like those in Miller Woods, are beach sand, muck, and peat of post-Nipissing-Algoma age. And the communities present there--black oak dunes, ponds, and marshes--are essentially the same as those of Miller Woods. But the corridor has been severely disturbed by man: a railroad spur was located there, industrial and domestic wastes have been dumped there, and there are numerous pathways used by off-road vehicles as well as hikers. Conspicuous in the open sandy areas created by disturbance are white sweet clover (Melilotus alba), prairie sunflower (Helianthus petiolaris), Virginia wild rye (Elymus virginicus), evening primrose (Oenothera biennis), and prickly-pear cactus (Opuntia compressa). The vegetation of a large and reasonably undisturbed dune east of Grand Avenue is ranked in Table 3-31. Sassafras and black cherry, as well as black oak and white oak, are present as trees. There are fewer species of shrubs and herbs present than in Miller Woods, but this is to be expected in view of the much smaller area involved.

Table 3-30. Stratum ranking of vegetation of Miller Woods upland--NW¼ NE¼ SW¼, section 31, T 37 N, R 7 W., West Unit.

Quercus velutina black oak	8	Trees
Quercus alba white oak	3	
Rhus radicans poison-ivy	5	Shrubs
Ceanothus americanus New Jersey tea	4	
Celastrus scandens bittersweet	4	
Cornus stolonifera red-osier dogwood	4	
Rhus copallina shining sumac	4	
Rosa blanda meadow rose	4	
Vitis sp. wild grape	4	
Vaccinium vacillans dryland blueberry	4	
Diervilla lonicera bush honeysuckle	3	
Opuntia compressa prickly-pear	3	
Parthenocissus quinquefolia Virginia creeper	3	
Ptelea trifoliata hoptree	3	
Rhus aromatica fragrant sumac	3	
Smilax sp. greenbrier	3	
Prunus virginiana choke cherry	2	
Rubus sp. rasp- black- berry	2	
Rhus typhina staghorn sumac	2	
Amelanchier sp. serviceberry	1	
Lonicera tatarica Tartarian honeysuckle	1	
Nyssa sylvatica blackgum	1	
Tilia americana basswood	1	
Viburnum acerifolium mapleleaf viburnum	1	

Table 3-30 continued

Aquilegia canadensis columbine	6	Herbs 23 May 79
Arabis lyrata rockcress	5	
Comandra richardsiana false toadflax	5	
Lupinus perennis lupine	5	
Aralia nudicaulis wild sarsaparilla	4	
Lithospermum caroliniense hairy puccoon	4	
Pedicularis canadensis lousewort	4	
Antennaria neglecta field pussytoes	3	
Castilleja coccinea Indian paintbrush	3	
Viola pedata birdfoot violet	3	
Carex cephalophora woodbank sedge	2	
Krigia biflora two-flowered dwarf dandelion	2	
Senecio pauperculus balsam ragwort	2	
Taraxacum officinale dandelion	2	
Zizia aurea golden Alexanders	2	
Asparagus officinalis asparagus	1	
Erigeron pulchellus robin-plantain	1	
Helianthus divaricatus woodland sunflower	6	27 July 78
Pteridium aquilinum latiusculum bracken fern	5	
Tephrosia virginiana goat's-rue	5	
Asclepias tuberosa butterfly-weed	4	
Euphorbia corollata flowering spurge	4	
Fragaria virginiana strawberry	4	
Monarda fistulosa wild bergamot	4	
Polygonatum sp. Solomon's-seal	4	

Table 3-30 continued

Rudbeckia hirta black-eyed Susan	4	
Smilacina stellata starry false Solomon's-seal	4	
Smilacina racemosa false Solomon's-seal	4	
Tradescantia ohiensis common spiderwort	4	
Amphicarpa bracteata hog-peanut	3	
Achillea millefolium yarrow	3	
Anemone cylindrica candle anemone	3	
Apocynum androsaemifolium spreading dogbane	3	
Artemisia caudata wormwood	3	
Asclepias verticillata whorled milkweed	3	
Asclepias syriaca common milkweed	3	
Elymus canadensis nodding wild rye	3	
Erigeron strigosus narrow-leaved daisy fleabane	3	
Lactuca canadensis wild lettuce	3	
Maianthemum canadense false lily-of-the-valley	3	
Monarda punctata villicaulis horsemint	3	
Oenothera biennis evening-primrose	3	
Phlox pilosa downy phlox	3	
Panicum virgatum switchgrass	3	
Saponaria officinalis soapwort	3	
Antennaria plantaginifolia plantain-leaved pussytoes	2	
Geranium maculatum wild geranium	2	
Prunella vulgaris self-heal	2	
Aster linariifolius stiff aster	5	15 Sept. 79
Liatris aspera rough blazing-star	4	
Solidago racemosa gillmani dune goldenrod	4	

Table 3-30 continued

Aster dumosus bushy aster	3
Aster vimineus small white aster	3
Coreopsis tripteris tall coreopsis	3
Solidago caesia blue-stemmed goldenrod	3
Solidago altissima tall goldenrod	3
Solidago speciosa showy goldenrod	3
Prenanthes alba white lettuce	3
Aster Azureus azure aster	2
Eupatorium altissimum tall boneset	2
Helianthus occidentalis western sunflower	2
Lespedeza sp. bush-clover	2

Table 3-31. Stratum ranks of vegetation on dune in corridor extending eastward from Miller Woods--SW¼ NE¼ NW¼, section 5, T 36 N, R 7 W., West Unit.

Quercus velutina black oak	7	Trees
Quercus alba white oak	3	
Sassafras albidum sassafras	3	
Prunus serotina black cherry	2	
Rhus radicans poison-ivy	5	Shrubs
Celastrus scandens bittersweet	4	
Rhus copallina shining sumac	4	
Rubus sp. rasp- black- berry	4	
Vaccinium vacillans dryland blueberry	4	
Vitis sp. wild grape	4	
Ceanothus americanus New Jersey tea	3	
Diervilla lonicera bush honeysuckle	3	
Hamamelis virginiana witch-hazel	3	
Lonciera tatarica Tartarian honeysuckle	3	
Opuntia compressa prickly-pear	3	
Ptelea trifoliata hoptree	3	
Rosa blanda meadow rose	3	
Prunus virginiana choke cherry	2	
Aquilegia canadensis columbine	5	Herbs 23 May 79
Arabis lyrata rockcress	4	
Aralia nudicaulis wild sarsaparilla	4	
Lithospermum caroliniense hairy puccoon	4	
Lupinus perennis lupine	4	
Smilacina stellata starry false Solomon's-seal	4	

Table 3-31 continued

Antennaria neglecta field pussytoes	3	
Artemisia caudata wormwood	3	
Asclepias syriaca common milkweed	3	
Fragaria virginiana strawberry	3	
Pedicularis canadensis lousewort	3	
Polygonatum sp. Solomon's-seal	3	
Viola pedata birdfoot violet	3	
Achillea millefolium yarrow	2	
Krigia biflora two-flowered dwarf dandelion	2	
Pteridium aquilinum latiusculum bracken fern	5	11 July 78
Tephrosia virginiana goat's-rue	5	
Euphorbia corollata flowering spruge	4	
Helianthus divaricatus woodland sunflower	4	
Asclepias tuberosa butterfly-weed	4	
Erigeron strigosus narrow-leaved daisy fleabane	3	
Phlox divaricata blue phlox	3	
Smilacina racemosa false Solomon's-seal	3	
Tradescantia ohiensis common spiderwort	3	
Aster linariifolius stiff aster	5	15 Sept. 79
Liatris aspera rough blazing-star	5	
Aster dumosus bushy aster	4	
Solidago racemosa gillmani dune goldenrod	4	
Solidago speciosa showy goldenrod	4	

Table 3-31 continued

Aster ericoides heath aster	3	
Coreopsis tripteris tall coreopsis	3	
Elymus canadensis nodding wild rye	3	
Lespedeza sp. bush-clover	3	
Monarda punctata villicaulis horsemint	3	
Prenanthes alba white lettuce	3	
Solidago altissima tall goldenrod	3	
Picris hieracioides bitterweed	2	

The community of the corridor described above extends eastward up to a large marsh. This marsh in the West Unit, described in the wetland section below, extends to County Line Road on the east and the Indiana Harbor Belt tracks on the north. To the south it is bounded by an open canopied black oak community which lies immediately to the north of a serivce road running alongside the Amtrak tracks. This savannah type stand, coded F-3 on the land use map, is formed on a low ridge containing shallow depressions which extends westward from County Line Road to the corridor but which is at most 400 feet wide. The substrates are beach and lake sands of Nipissing age. The plants of this community are ranked in Table 3-32. Black oak is clearly the dominant species, but because of the openness of the canopy it is given a rank of 6 rather than the 8 it received in Miller Woods. Over a hundred species are found in this long and narrow community. Contributing significantly to this species richness is the habitat diversity provided by the shallow depressions in the ridge which are near the water table and much wetter than elsewhere. Cottonwood is the dominant tree in these depressions. Overall, however, the depressions are not sufficiently large to warrant separate treatment of their communities in the wetland section. Moreover, some species are found both on the ridge and in the depressions. Therefore, we have simply indicated those species which are found primarily in the depressions by marking them with an asterisk. Another matter worthy of note is that a fair number of prairie species, notably big bluestem and Indian grass, are present in this savannah type stand.

To the east of the stand described in the preceding paragraph, between the Amtrak tracks and the eastern portion of Long Lake, is a stand much like it. The ridge of Nipissing beach and lake sands, however, is somewhat higher and does not have numerous depressions in it, though to the west there is a low portion into which a lobe of the marsh which lies to the north extends. The vegetation of this stand is ranked in Table 3-33. The canopy of the trees is relatively open yet more closed than that of the stand to the west. Shining sumac and poison ivy are the most important plants of the shrub stratum. No species of herbaceous plant is ranked higher than 4. In this savannah type community are found several prairie species, notably rattlesnake-master and wild indigo. Those herbs which are found in the damper portions of the community, where it adjoins the marsh, are indicated with an asterisk.

Northwest of Long Lake is a crescent-shaped dune ridge of post-Nipissing-Algoma age. It is centered at NE¼ NW¼ SW¼, section 34, T 37 N, R 7 W. A savannah type community dominated by black oak and coded F-2 on the land use map is present here. The vegetation of this stand is ranked in Table 3-34. The shrubby and herbaceous vegetation under the relatively open canopy of trees is quite dense. Dryland blueberry and huckleberry, together with the ubiquitous poison-ivy, are the important shrubs. None of the herbs is especially important; there are rather a large number of species of moderate importance. A number of the herbaceous species--such as tall coreopsis, roundheaded bush-clover, and the blazing-stars--are characteristic of prairies.

Table 3-32. Stratum ranks of vegetation of savannah type community west of County Line Road and north of Amtrak tracks -- center of SW¼ SE¼, section 33, T 37 N. R 7 W., West Unit.

Quercus velutina black oak	6	Trees on the ridge
Quercus alba white oak	4	
Acer rubrum red maple	2	
Sassafras albidum sassafras	2	
Populus deltoides cottonwood	6	Trees in depressions
Salix sp. willow	4	
. Acer rubrum red maple	2	
. Sassafras albidum sassafras	2	
Rhus copallina shining sumac	5	Shrubs
Populus tremuloides quaking aspen	5*	
Rhus typhina staghorn sumac	4	
Sambucus canadensis common elder	4*	
Diervilla lonicera bush honeysuckle	4	
Rubus sp. rasp- black- berry	4	
Rosa blanda meadow rose	3	
Vaccinium vacillans dryland blueberry	3	
Spiraea alba meadow-sweet	2*	
Vitis sp. wild grape	2	
Ceanothus americanus New Jersey tea	2	
Aronia melanocarpa black chokeberry	2	
Lupinus perennis lupine	5	Herbs 21 May 79
Arabis lyrata rockcress	3	
Lithospermum caroliniense hairy puccoon	3	

Table 3-32 continued

Lithospermum canescens hoary puccoon	3	
Achillea millefolium yarrow	3	
Antennaria neglecta field pussytoes	3	
Aquilegia canadensis columbine	3	
Pedicularis canadensis lousewort	3*	
Potentilla simplex common cinquefoil	3*	
Smilacina stellata starry false Solomon's-seal	3	
Antennaria plantaginifolia plantain-leaved pussytoes	2	
Aralia nudicaulis wild sarsaparilla	2	
Equisetum arvense field horsetail	2*	
Maianthemum canadense false lily-of-the-valley	2	
Senecio pauperculus balsam ragwort	2	
Osmunda regalis spectabilis royal fern	1*	
Silene cucubalus bladder campion	1	
Viola pedata birdfoot violet	1	
Viola sp. violet	1	
Phragmites communis berlandieri common reed	6*	11 July 78
Calamogrostis inexpansa brevior northern reedgrass	5*	
Euphorbia corollata flowering spurge	5	
Typha latifolia common cattail	5*	
Rudbeckia hirta black-eyed Susan	4	
Tradescantia ohiensis common spiderwort	4	
Saponaria officinalis soapwort	4	
Achillea millefolium yarrow	3	

Table 3-32 continued

Solanum dulcamara bittersweet nightshade	2	
Asparagus officinalis asparagus	1	
Cuscuta sp. dodder	1	
Polygonatum sp. Solomon's-seal	1	
Helianthus giganteus giant sunflower	6*	15 Sept. 79
Aster vimineus small white aster	5*	
Eupatorium perfoliatum common boneset	5*	
Solidago altissima tall goldenrod	5*	
Solidago speciosa showy goldenrod	5	
Andropogon geradi big bluestem	4*	
Aster azureus azure aster	4	
Bidens frondosa beggar-ticks	4*	
Coreopsis tripteris tall coreopsis	4*	
Eupatorium maculatum spotted Joe-Pye-weed	4*	
Liatris aspera rough blazing-star	4	
Solidago graminifolia grass-leaved goldenrod	4*	
Aster ericoides heath aster	3	
Aster linariifolius stiff aster	3	
Aster novae-angliae New England aster	3	
Aster umbellatus flat-topped white aster	3	
Eupatorium altissimum tall boneset	3	
Lespedeza sp. bush-clover	3	
Monarda punctata villicaulis horsemint	3	

Table 3-32 continued

Asclepias tuberosa butterfly-weed	3
Asclepias syriaca common milkweed	3
Fragaria virginiana strawberry	3
Helianthus divaricatus woodland sunflower	3
Erigeron strigosus narrow-leaved daisy fleabane	3
Lythrum salicaria purple loosestrife	3*
Phalaris arundinacea reed canary grass	3*
Pteridium aquilinum latiusculum bracken fern	3
Stachys tenuifolia hispida rough hedge-nettle	3*
Smilacina racemosa false Solomon's-seal	3
Urtica procera tall nettle	3*
Verbascum thapsus common mullein	3
Thelypteris palustris pubescens marsh fern	3*
Artemisia caudata wormwood	2
Cannabis sativa marijuana	2
Apocynum androsaemifolium spreading dogbane	2
Iris virginica shrevei wild iris	2*
Impatiens biflora touch-me-not	2
Phlox pilosa downy phlox	2
Polygonum sp. knotweed, smartweed	2*
Mirabilis nyctaginea wild four-o'clock	2
Polanisia dodecandra clammy-weed	2
Polygala polygama obtusata pink milkwort	2
Onoclea sensibilis sensitive fern	2*
Polygonum sp. knotweed, smartweed	3*
Solidago juncea early goldenrod	3
Sorghastrum nutans Indian grass	3
Ambrosia trifida great ragweed	2
Picris hieraciodes bitterweed	2
Verbena engelmanni (hastata X urticifolia) Engelmann vervain	1*

*Primarily in wet depressions.

Table 3-33. Stratum ranks of vegetation of forest stand on dune ridge southeast of Long Lake--center of E½, section 34, T 37 N, R 7 W., West Unit.

Quercus velutina black oak	6	Trees
Quercus alba white oak	4	
Nyssa sylvatica blackgum	2	
Sassafras albidum sassafras	2	
Rhus copallina shining sumac	4	Shrubs
Rhus radicans poison-ivy	4	
Rosa blanda meadow rose	3	
Rubus sp. rasp- black- berry	3	
Salix spp. willow shrubs	3	
Vaccinium vacillans dryland blueberry	3	
Vitis sp. wild grape	3	
Viburnum acerifolium mapleleaf viburnum	2	
Asclepias syriaca common milkweed	4	Herbs 26 July 74
Euphorbia corollata flowering spurge	4	
Helianthus divaricatus woodland sunflower	4	
Monarda fistulosa wild bergamot	4	
Pedicularis canadensis lousewort	4	
Pteridium aquilinum latiusculum bracken fern	4	
Rudbeckia hirta black-eyed Susan	4	
Stachys palustris homotricha marsh hedge-nettle	4*	
Tradescantia ohiensis common spiderwort	4	
Asclepias tuberosa butterfly-weed	3	
Campanula aparinoides marsh bellflower	3*	

*In portion of adjoining marsh

Table 3-33 continued

Coreopsis tripteris tall coreopsis	3	
Eryngium yuccifolium rattlesnake-master	3	
Lithospermum caroliniense hairy puccoon	3	
Psycnanthemum tenuifolium slender mountain-maint	3*	
Tephrosia virginiana goat's-rue	3	
Verbascum thapsus common mullein	3	
Achillea millefolium yarrow	2	
Asparagus officinalis asparagus	2	
Baptisia leucantha wild-indigo	2	
Daucus carota wild carrot	2	
Erigeron strigosus narrow-leaved daisy fleabane	2	
Polygonatum sp. Solomon's-seal	2	
Smilacina racemosa false Solomon's-seal	2	
Oxypolis rigidior cowbane	1	
Solidago altissima tall goldenrod	4	27 Sept. 74
Aster azureus azure aster	3	
Aster novae-angliae New England aster	3	
Aster umbellatus flat-topped white aster	3	
Gentiana crinita fringed gentian	3	
Lespedeza capitata round-headed bush-clover	3	
Liatris aspera rough blazing-star	3	
Prenanthes alba white lettuce	3	
Solidago altissima tall goldenrod	3	
Solidago gymnospermoides lance-leaved goldenrod	3	
Lespedeza hirta hairy bush-clover	2	

*In portion of adjoining marsh

Table 3-34. Stratum ranks of vegetation of forest stand on dune ridge northwest of Long Lake--NE¼ NW¼ SW¼, section 34, T 37 N, R 7 W., West Unit.

Quercus velutina black oak	7	Trees
Quercus alba white oak	4	
Sassafras albidum sassafras	3	
Robinia pseudo-acacia black locust	1	
Vaccinium vacillans dryland blueberry	6	Shrubs
Gaylussacia baccata huckleberry	5	
Rhus radicans poison-ivy	5	
Ceanothus americanus New Jersey tea	4	
Prunus virginiana choke cherry	4	
Vitis sp. wild grape	4	
Diervilla lonicera bush honeysuckle	3	
Rhus copallina shining sumac	3	
Rosa blanda meadow rose	3	
Alnus rugosa americana speckled alder	2	
Celastrus scandens bittersweet	2	
Cornus stolonifera red-osier dogwood	2	
Ptelea trifoliata hoptree	2	
Rhus typhina staghorn sumac	2	
Viburnum prunifolium black-haw	2	
Coreopsis tripteris tall coreopsis	4	Herbs 29 July 74
Euphorbia corollata flowering spurge	4	
Helianthus divaricatus woodland sunflower	4	
Pteridium aquilinum latiusculum bracken fern	4	

Table 3-34 continued

Tephrosia virginiana goat's-rue	4	
Asclepias tuberosa butterfly-weed	3	
Liatris cylindracea cylindric blazing-star	3	
Monarda fistulosa wild bergamot	3	
Monarda punctata villicaulis horsemint	3	
Smilacina racemosa false Solomon's-seal	3	
Smilacina stellata starry false Solomon's-seal	3	
Asclepias syriaca common milkweed	2	
Galium circaezans wild licorice	2	
Aster azureus azure aster	4	4 Oct. 74
Aster linariifolius stiff aster	4	
Lespedeza capitata round-headed bush-clover	4	
Liatris aspera rough blazing-star	3	
Solidago caesia blue-stemmed goldenrod	3	
Solidago nemoralis gray goldenrod	3	
Solidago speciosa showy goldenrod	3	
Artemisia caudata wormwood	2	
Aster dumosus bushy aster	2	
Elymus canadensis nodding wild rye	2	
Panicum spretum spurned panic-grass	2	
Prenanthes alba white lettuce	2	
Aster novae-angliae New England aster	1	
Cycloloma atriplicifolium winged pigweed	1	
Kuhnia eupatorioides corymbulosa false boneset	1	
Oenothera biennis evening-primrose	1	

To the north of the preceding stand is another, in the eastern half of NE¼ NW¼, section 34, T 37 N, R 7 W, developed on post-Nipissing-Algoma dunes sands. This stand is quite diverse. Toward the north there is some infiltration of sand from the open dunes adjoining it in that direction. To the east the dunes rise high above the adjoining areas which have been mined for sand. Most important of all, there is a depression in the middle of the stand in which litter accumulates and which is considerably more moist than the surrounding dunes. Such moist depressions are referred to as mesophytic pockets, and this is the best defined one in the national lakeshore. The plants of this stand, in all aspects of its diversity, are ranked in Table 3-35. Black oak shares dominance in this case with red oak, a species not otherwise found in black oak communities on relatively young substrates but one regularly important on mesic substrates. Moreover, the trees of this stand are greater in height and diameter than are those of other stands on relatively young substrates. These facts are attributable to the moist soil conditions found in the mesophytic pocket were ranked separately, the only species on the list of all three strata which is known to be restricted to the pocket is sugar maple. The very presence of sugar maple, a species which shares dominance in the climax community of this region and which requires mesic conditions, is of considerable interest. There is nothing particularly distinctive about the shrub and herb strata.

A dune complex is found between U.S. 12 on the north and the Baltimore and Ohio tracks on the south, extending from about half a mile from where U.S. 12 and the Baltimore and Ohio tracks intersect on the west to about half a mile west of County Line Road on the east. This is a Tolleston-Algonquin shoreline complex, thus somewhat older than the dunes considered above, consisting of beach sand, dune sand, muck and peat. There are several crescent shaped dunes in this complex, readily distinguished on the topographic maps, lying on a base between 600 and 610 feet in elevation. The vegetation of the plant community developed on the dunes, coded F-2 on the land use map, is ranked in Table 3-36. Nearly a hundred plant species are present. Black oak is clearly the dominant tree. Sharing importance in the shrub stratum are several species common in the black oak dunes described above: lowbush and dryland blueberry, meadow rose, bush honeysuckle, and New Jersey tea; ranked as high as they in this community is black chokeberry, a shrub requiring a moist substrate. The single silverberry present here is the only one we encountered in the National Lakeshore. False heather, a species considered by many to be an especially rare plant, is quite abundant on a relatively open sandy area in the western portion of this stand. The most important herbs--lupine, starry false Solomon's-seal, birdfoot violet, flowering spurge, butterfly-weed, bracken-fern, woodland sunflower, rough blazing-star, and tall goldenrod--are, with the exception of birdfoot violet, species regularly ranked high in the black oak dunes described above. Hoary puccoon, a species not listed on the younger dunes described above, is present in addition to hairy puccoon, a species regularly listed above. A number of prairie species, such as compass plant, wild indigo, and Indian grass, are present, though not of great importance, in clearings. Also present are many weed species--plantain, dandelion, peppergrass, and sheep sorrel--indicators of human disturbance.

Table 3-35. Stratum ranks of vegetation of forest stand with mesophytic pocket north of Long Lake--at center of E½ NE¼ NW¼, section 34, T 37 N, R 7 W., West Unit.

Quercus velutina black oak	7	Trees	
Quercus rubra red oak	7		
Quercus alba white oak	6		
Tilia americana basswood	4		
Amelanchier sp. serviceberry	3		
Cornus florida flowering dogwood	3		
Ostrya virginiana ironwood	3		
Pinus strobus white pine	3		
Prunus serotina black cherry	3		
Sassafras albidum sassafras	3		
Fraxinus americana white ash	2		
Acer rubrum red maple	1		
Acer saccharum sugar maple	1		
Juniperus virginiana creba red cedar	1		
Prunus virginiana choke cherry	5	Shrubs	
Parthenocissus quinquefolia Virginia creeper	4		
Smilax sp. greenbrier	4		
Vitis sp. wild grape	4		
Cornus sp. dogwood	3		
Hamamelis virginiana witch-hazel	3		
Ribes sp. currant	3		
Rosa blanda meadow rose	3		
Vaccinium vacillans dryland blueberry	3		

Table 3-35 continued

Viburnum acerifolium mapleleaf viburnum	3		
Arctostaphylos uva-ursi coactilis bearberry	2		
Viburnum dentatum arrow-wood	1		
Arabis lyrata rockcress	3	Herbs 29 Apr. 74	
Viola pedata birdfoot violet	2		
Anemonella thalictroides rue anemone	4	13 May 75	
Aquilegia canadensis columbine	4		
Fragaria virginiana strawberry	3		
Maianthemum canadense false lily-of-the-valley	3		
Podophyllum peltatum May-apple	3		
Smilacina stellata starry false Solomon's-seal	3		
Lithospermum caroliniense hairy puccoon	2		
Oenothera biennis evening-primrose	1		
Carex pensylvanica Pennsylvania sedge	6	15 Aug. 74	
Aralia nudicaulis wild sarsaparilla	5		
Smilacina stellata starry false Solomon's-seal	5		
Panicum sp. panic-grass	4		
Artemisia caudata wormwood	3		
Euphorbia corollata flowering spurge	3		
Galium pilosum hairy bedstraw	3		
Helianthus divaricatus woodland sunflower	3		
Smilacina racemosa false Solomon's-seal	3		
Tradescantia ohiensis common spiderwort	3		

Table 3-35 continued

Achilles millefolium yarrow	2		
Antennaria sp. pussytoes	2		
Liatris aspera rough blazing-star	2		
Monarda fistulosa wild bergamot	2		
Monarda punctata villicaulis horsemint	2		
Monotropa uniflora Indian pipe	2		
Polygonatum sp. Solomon's-seal	2		
Asclepias exaltata tall milkweed	1		
Galium circaezans wild licorice	1		
Lactuca canadensis wild lettuce	1		
Aster azureus Azure aster	3	4 Oct. 74	
Aster dumosus bushy aster	3		
Aster linariifolius stiff aster	3		
Solidago caesia blue-stemmed goldenrod	3		
Solidago speciosa showy goldenrod	3		
Prenanthes alba white lettuce	2		
Adiantum pedatum maidenhair fern	1		
Asplenium platyneuron ebony spleenwort	1		

Table 3-36. Stratum ranks of vegetation of forest stand on dunes south of U.S. 12 and west of County Line Road--SE¼ SE¼ NE¼, section 5, T 36 N, R 7 W., West.

Quercus velutina black oak	8	Trees
Quercus alba white oak	3	
Sassafras albidum sassafras	3	
Prunus pensylvanica pin cherry	2	
Acer rubrum red maple	1	
Pinus banksiana jack pine	1	
Aronia melanocarpa black chokeberry	4	Shrubs
Ceanothus americanus New Jersey tea	4	
Diervilla lonicera bush honeysuckle	4	
Rosa blanda meadow rose	4	
Vaccinium vacillans dryland blueberry	4	
Vaccinium angustifolium laevifolium lowbush blueberry	4	
Celastrus scandens bittersweet	3	
Hudsonia tomentosa false heather	3	
Opuntia compressa prickly-pear	3	
Rhus copallina shining sumac	3	
Rubus sp. rasp- black- berry	3	
Eleagnus commutata silverberry	1	
Lupinus perennis lupine	6	Herbs 21 May 79
Smilacina stellata starry false Solomon's-seal		
Viola pedata birdfoot violet	5	
Aquilegia canadensis columbine	4	
Arabis lyrata rockcress	4	
Lithospermum carolinense hairy puccoon	4	

Table 3-36 continued

Lithospermum canescens hoary puccoon	4
Antennaria neglecta field pussytoes	3
Aralia nudicaulis wild sarsaparilla	3
Krigia virginica Virginia dwarf dandelion	3
Pedicularis canadensis lousewort	3
Plantago major plantain	3
Potentilla simplex common cinquefoil	3
Taraxacum officinale dandelion	3
Anemone quinquefolia wood anemone	2
Equisetum hyemale affine common scouring-rush	2
Galium aparine cleavers	2
Galium circaezans wild licorice	2
Geranium maculatum wild geranium	2
Lactuca canadensis wild lettuce	2
Lepidium virginicum pepper-grass	2
Maianthemum canadense false lily-of-the-valley	2
Rumex acetosella sheep sorrel	2
Urtica procera tall nettle	2
Viola sagittata arrow-leaved violet	2
Verbascum thapsus common mullein	2
Arctium sp. burdock	1
Comandra richardsiana false toadflax	1
Lechea minor small pinweed	1
Senecio pauperculus balsam ragwort	1

Table 3-36 continued

Silphium laciniatum compass-plant	1	
Euphorbia corollata flowering spurge	6	11 July 78
Asclepias tuberosa butterfly-weed	5	
Pteridium aquilinum latiusculum bracken fern	5	
Asclepias syriaca common milkweed	4	
Coreopsis tripteris tall coreopsis	4	
Fragaria virginiana strawberry	4	
Koeleria cristata Junegrass	4	
Panicum virgatum switchgrass	4	
Phlox pilosa downy phlox	4	
Polygonatum sp. Solomon's-seal	4	
Rudbeckia hirta black-eyed Susan	4	
Tephrosia virginiana goat's-rue	4	
Tradescantia ohiensis common spiderwort	4	
Achillea millefolium yarrow	3	
Artemisia caudata wormwood	3	
Erigeron strigosus narrow-leaved daisy fleabane	3	
Monarda punctata villicaulis horsemint	3	
Oenothera biennis evening-primrose	3	
Smilacina racemosa false Solomon's-seal	3	
Apocynum androsaemifolium spreading dogbane	2	
Asparagus officinalis asparagus	2	
Campanula rotundifolia harebell	2	
Helianthus divaricatus woodland sunflower	5	14 Sept. 79

Table 3-36 continued

Liatris aspera rough blazing-star	5	
Solidago altissima tall goldenrod	5	
Aster dumosus bushy aster	4	
Aster ericoides heath aster	4	
Aster linariifolius stiff aster	4	
Aster novae-angliae New England aster	4	
Solidago juncea early goldenrod	4	
Solidago nemoralis gray goldenrod	4	
Aster azureus azure aster	3	
Eupatorium altissimum tall boneset	3	
Eupatorium serotinum late boneset	3	
Helianthus occidentalis western sunflower	3	
Solidago racemosa gillmani dune goldenrod	3	
Aureolaria pedicularia fern-leaved false foxglove	2	
Baptisia leucantha wild-indigo	2	
Lespedeza sp. bush-clover	2	
Picris hieracioides bitterweed	2	
Mollugo verticillata carpet-weed	1	
Polygonella articulata sand knotweed	1	
Sorghastrum nutans Indian grass	1	

On the low ground between the dunes described in the previous paragraph is developed still another type of community coded F-3 on the land use map. It is a wetland community, more specifically a shrub wetland, and could be treated just as appropriately (if not more so) in the wetland section below, but it is considered here to emphasize that these are not sharply discontinuous communities. (A shrub wetland adjacent to the Baltimore and Ohio tracks, however, which has a much wetter substrate as indicated by the importance of cattail in it, is described in the wetland section). The vegetation of this shrub wetland is ranked in Table 3-37. None of the tree species has attained sufficient size to be ranked in the tree stratum. Quaking aspen predominates in some of the low areas, cottonwood in others, and willow in still others; but overall quaking aspen is the most important. Shining sumac is a common associate of each of the above. Black chokeberry extends upward onto the dunes giving this species the ranking of 4 we noted there. None of the herbaceous species is especially prominent in the spring or summer aspects; in the fall, however, giant sunflower, boneset, and grass-leaved goldenrod are important.

A dune complex quite similar to that described in the next to the last paragraph lies east of County Line Road and south of U.S. 12. It extends to the east and southeast to Stagecoach Road and southward 2000 feet or so to where there has been sand mining. As in the complex above, the substrates are beach and dune sands and muck and peat of the Tolleston-Algoquin shoreline complex. Just south of U.S. 12 there is a sand ridge which extends eastward from County Line Road through most of the length of this area. A large and high dune lies to the southeast. A series of ridges and low dunes extend in a northwest-southeast direction between these two features. Between the dunes and ridges are depressions which like those described immediately above are at an elevation of 600 to 610 feet, but which unlike them are sufficientlywet that extensive marsh communities (coded E-2 on the land use map) are developed. These marshes will be treated in the wetland section below. Considered here is the community which develops on the upland ridges and dunes of this complex. Coded F-2 on the land use map, its vegetation is ranked in Table 3-38. Only two tree species, black and white oak, are found in this extensive community, and black oak is clearly the dominant. The canopy is not continuous, as the F-2 code indicates, but the trees are not nearly as widely scattered as in the savannah type communities described above (which are coded F-3). New Jersey tea ranks high in the shrub stratum; otherwise there is nothing unusual among the shrubs. Most impressive among the herbs is the number of species--almost a hundred--undoubtedly a reflection of the habitat diversity and the large size of the area. The most important species, lupine in the spring, goat's-rue in the summer, and stiff aster in the fall, are regularly among the important species in black oak communities. Other items worthy of note are that hoary puccoon is present as well as hairy puccoon, that several weed species (dandelion, sheep sorrel, and carpet-weed) are present, and that a single wild-indigo (a prairie species) was observed.

Table 3-37. Stratum ranks of vegetation in low lying areas between dunes south of U.S. 12 and west of County Line Road -- SE¼ SE¼ NE¼, section t, 5 36 N, R 7 W., west.

Populus tremuloides quaking aspen	7	Shrubs
Populus deltoides cottonwood	5	
Salix sp. willow	5	
Rhus copallina shining sumac	5	
Aronia melanocarpa black chokeberry	4	
Rubus sp. rasp- black- berry	4	
Cornus sp. dogwood	3	
Rhus typhina staghorn sumac	3	
Spiraea tomentosa hardhack	3	
Sambucus canadensis common elder	3	
Symplocarpus foetidus skunk-cabbage	4	Herbs 21 May 79
Asclepias syriaca common milkweed	4	11 July 78
Calamogrostis inexpansa brevior northern reedgrass	4	
Hypericum perforatum common St.-John's-wort	4	
Lilium michiganense Turk's-cap lily	3	
Monarda fistulosa wild bergamot	3	
Penstemon digitalis foxglove beardtongue	3	
Phragmites communis berlandieri common reed	3	
Potentialla recta rough-fruited cinquefoil	3	
Tragopogon sp. goat's-beard	3	
Asclepias incarnata swamp milkweed	2	
Smilax lasioneura carrion-flower	2	
Helianthus giganteus giant sunflower	6	14 Sept. 79
Eupatorium perforliatum common boneset	5	
Solidago graminifolia grass-leaved goldenrod	5	
Solidago altissima tall goldenrod	4	
Solidago rugosa aspera thick-leaved rough-stemmed goldenrod	4	
Aster novae-angliae New England aster	3	
Eupatorium maculatum spotted Joe-Pye-weed	3	
Gerardia purpurea purple gerardia	3	
Scirpus cyperinus wool-grass	3	
Verbena engelmanni (hastata X urticifolia) Engelmann vervain	3	
Bidens coronata crowned tickseed-sunflower	2	
Liatris spicata dense blazing-star	2	

Table 3-38. Stratum ranks of vegetation of forest stand on dune complex south of U.S. 12 and east of County Line Road -- center of S½ SE¼, section 34, T 37 N, R 7 W., West Unit.

Quercus velutina black oak	8	Trees
Quercus alba white oak	3	
Ceanothus americanus New Jersey tea	5	Shrubs
Rhus copallina shining sumac	5	
Opuntia compressa Prickly-pear	4	
Rosa blanda meadow rose	4	
Vaccinium vacillans dryland blueberry	4	
Vaccinium angustifolium laevifolium lowbush blueberry	4	
Diervilla lonicera bush honeysuckle	3	
Nyssa sylvatica blackgum	3	
Parthenocissus quinquefolia Virginia creeper	3	
Rhus radicans poison-ivy	3	
Rubus hispidus dewberry	3	
Vitis sp. wild grape	3	
Rhus typhina staghorn sumac	2	
Aronia melanocarpa black chokeberry	2	
Pedicularis canadensis lousewort	3	
Oenothera biennis evening-primrose	3	
Polygonatum sp. Solomon's-seal	3	
Asclepias verticillata whorled milkweed	2	
Agropyron smithii Smith wheat-grass	2	
Brachyelytrum erectum short-husked grass	2	
Carex brevior short sedge	2	
Coreopsis lanceolata lance-leaved coreopsis	2	

Table 3-38 continued

Polygala polygama obtusata pink milkwort	2	
Krigia biflora two-flowered dwarf dandelion	2	
Baptisia leucantha wild-indigo	1	
Aster linariifolius stiff aster	6	14 Sept. 79
Helianthus divaricatus woodland sunflower	5	
Liatris aspera rough blazing-star		
Monarda punctata villicaulis horsemint	5	
Solidago juncea early goldenrod	5	
Solidago speciosa showy goldenrod	5	
Aster umbellatus flat-topped white aster	4	
Aureolaria pedicularia fern-leaved false foxglove	4	
Erigeron canadensis horseweed	4	
Hypoxis hirsuta stargrass	1	
Sisyrinchium albidum common blue-eyed grass	1	
Tephrosia virginiana goat's-rue	6	6 July 78
Artemisia caudata wormwood	5	
Coreopsis tripteris tall coreopsis	5	
Achillea millefolium yarrow	4	
Asclepias tuberosa butterfly-weed	4	
Euphorbia corollata flowering spurge	4	
Koeleria cristata Junegrass	4	
Phlox pilosa downy phlox	4	
Pteridium aquilinum latiusculum braken fern	4	
Rudbeckia hirta black-eyed Susan	4	

Table 3-38 continued

Smilacina racemosa false Solomon's-seal	4	
Tradescantia ohiensis common spiderwort	4	
Asclepias syriaca common milkweed	3	
Campanula rotundifolia harebell	3	
Erigeron strigosus narrow-leaved daisy fleabane	3	
Fragaria virginiana strawberry	3	
Helianthus divaricatus woodland sunflower	3	
Lepidium virginicum pepper-grass	3	
Lupinus perennis lupine	6	Herbs 25 May 79
Arabis lyrata rockcress	5	
Comandra richardsiana false toadflax	4	
Smilacina stellata starry false Solomon's-seal	4	
Viola sp. violet	4	
Aquilegia canadensis columbine	3	
Aralia nudicaulis wild sarsaparilla	3	
Lithospermum caroliniense hairy puccoon	3	
Lithospermum canescens hoary puccoon	3	
Taraxacum officinale dandelion	3	
Antennaria neglecta field pussytoes	2	
Antennaria plantaginifolia plantain-leaved pussytoes	2	
Carex pensylvanica Pennsylvania sedge	2	
Geranium maculatum wild geranium	2	
Krigia virginica Virginia dwarf dandelion	2	

Table 3-38 continued

Maianthemum canadense false lily-of-the-valley	2
Phlox divaricata blue phlox	2
Potentilla simplex common cinquefoil	2
Rumex acetosella sheep sorrel	2
Asparagus officinalis asparagus	1
Lespedeza sp. bush-clover	4
Solidago nemoralis gray goldenrod	4
Aster dumosus bushy aster	3
Aster ericoides heath aster	3
Aster vimineus small white aster	3
Picris hieracioides bitterweed	3
Solidago altissima tall goldenrod	3
Solidago graminifolia grass-leaved goldenrod	3
Aster azureus azure aster	2
Aster novae-angliae New England aster	2
Cenchrus longispinus sandbur	2
Eupatorium altissimum tall boneset	2
Helianthus occidentalis western sunflower	2
Liatris spicata dense blazing-star	2
Mollugo verticillata carpet-weed	2
Polygonella articulata sand knotweed	2
Prenanthes alba white lettuce	1
Verbascum thapsus common mullein	1

East of Ogden Dunes, to the south of the blowout complex previously described, centered at the center of the SW¼ SW¼ of section 25, T 37 N, R 7 W, is a forested area coded F-1 on the land use map. The substrate is post-Nipissing-Algoma dune sand. The plants of this community are ranked in Table 3-39. As indicated by the F-1 coding, this stand has a rather dense canopy. Black oak is clearly the dominant tree species, but associated with it are several other species with rankings of 5 and 4, among them ironwood. The only previous black oak community in which ironwood has been listed is that wihin and around the mesophytic pocket. In this particular case a pocket is not so obvious, but on examination of the topographic map it is seen that there is a depression here, surrounded by low ridges to the east and south, by high ones to the west and north. Thus conditions are favorable for the accumulation of litter and the development of a moist substrate. Attesting to this is the presence of a sugar maple sapling in the community. Whether or not this is considered a mesophytic pocket is immaterial. What is important is that the substrate here is more mesic than that on which the other black communities considered above (with the exception, of course, of that of the mesophytic pocket) are developed. The shrub stratum of this community is particularly rich in species, though only dwarf hackberry is not elsewhere listed. There are relatively few herb species present. The most important of these are those regularly found in black oak communities. This is the only community in the national lakeshore, however, in which we found ginseng.

The two most extensive stands of black oak dunes in the national lakeshore lie farther to the east than those described above, in the Cowles Unit and East Unit. The Cowles Unit stand may for convenience be divided into western and eastern portions. The west portion, coded F-1 on the land use map, extends from the Northern Indiana Public Service Company property line on the west to Mineral Springs Road on the east, and from the foredunes on the north to the ponds, marshes, and swamp forests on the south. The dune sand substrate adjacent to the ponds, marshes, and swamp forests is of Algonquin age; the dune sand substrate adjoining the foredunes is of post-Nipissing-Algoma age; between are Nipissing dunes and pockets of muck and peat. Within this stand are scattered several ponds (E-1), patches of marsh (E-2), and areas with open canopy (F-2). Late in the 1920s and into the 1930s there was a lane leading from Mineral Springs Road along the southern margin of this stand to a 9-hole golf course laid out in the middle of the tract, but there is little evidence today of this use except that along the trail which follows the old lane there are wide places which served as turn-outs when the lane was in use. The plants of this stand are ranked in Table 3-40. Black oak is clearly the dominant tree species; a number of other species are present, but have relatively low rankings. The most important shrubs are the dryland and lowbush blueberries; huckleberry, meadow rose, and poison-ivy are important associates. Pennsylvania sedge and bracken fern are the most important herbaceous species, followed closely by false lily-of-the-valley, flowering spurge, rough blazing-star, and Junegrass. The long list of

Table 3-39. Stratum ranks of vegetation of forest stand on dune complex east of Ogden Dunes--center of SW¼ SW¼, section 25, T 37 N, R 7 W., West Unit.

Quercus velutina black oak	7	Trees
Sassafras albidum sassafras	5	
Ostrya virginiana ironwood	4	
Tilia americana basswood	4	
Juniperus virginiana creba red cedar	3	
Pinus banksiana jack pine	3	
Quercus alba white oak	3	
Rhus radicans poison-ivy	5	Shrubs
Vitis sp. wild grape	5	
Celastrus scandens bittersweet	4	
Rhus aromatica fragrant sumac	4	
Rosa blanda meadow rose	4	
Smilax sp. greenbrier	4	
Arctostaphylos uva-ursi coactilis bearberry	3	
Cornus stolonifera red-osier dogwood	3	
Hamamelis virginiana witch-hazel	3	
Parthenocissus quinquefolia Virginia creeper	3	
Prunus virginiana choke cherry	3	
Ptelea trifoliata hoptree	3	
Ribes sp. currant	3	
Rhus copallina shining sumac	3	
Vaccinium vacillans dryland blueberry	3	
Viburnum acerifolium mapleleaf viburnum	3	
Amelanchier sp. serviceberry	2	

Table 3-39 continued

Berberis thunbergii Japanese barberry	2	
Celtis tenuifolia dwarf hackberry	2	
Juniperus communis depressa ground juniper	2	
Lonicera tatarica Tartarian honeysuckle	2	
Opuntia compressa prickly-pear	2	
Acer saccharum sugar maple	1	
Morus rubra red mulberry	1	
Aralia nudicaulis wild sarsaparilla	4	Herbs 25 May 79
Osmorhiza claytoni hairy sweet cicely	4	
Smilacina stellata starry false Solomon's-seal	4	
Aquilegia canadensis columbine	3	
Galium circaezans wild licorice	3	
Maianthemum canadense false lily-of-the-valley	3	
Arisaema triphyllum jack-in-the-pulpit	2	
Botrychium virginianum rattlesnake fern	2	
Carex rosea rose-like sedge	2	
Viola pubescens eriocappa smooth yellow violet	2	
Euphorbia corollata flowering spurge	3	23 Aug. 78
Helianthus divaricatus woodland sunflower	3	
Polygonatum sp. Solomon's-seal	3	
Pteridium aquilinum latiusculum bracken fern	3	
Tephrosia virginiana goat's-rue	3	
Prenanthes sp. rattlesnake-root	2	
Solidago caesia blue-stemmed goldenrod	4	21 Sept. 79
Anemone cylindrica candle anemone	3	
Eupatorium rugosum white snakeroot	3	
Panax quinquefolium ginseng	1	
Similax lasioneura carrion-flower	1	

Table 3-40. Stratum ranking of plant species of forest between Bailly generating station and Mineral Springs Road at Dune Acres--at center of E½, section 21, T 37 N, R 6 W., Cowles Unit.

Quercus velutina black oak	8	Trees
Prunus serotina black cherry	4	
Quercus alba white oak	4	
Sassafras albidum sassafras	4	
Nyssa sylvatica blackgum	3	
Acer rubrum red maple	2	
Amelanchier sp. serviceberry	2	
Juniperus virginiana creba red cedar	2	
Pinus banksiana jack pine	2	
Pinus strobus white pine	2	
Tilia americana basswood	2	
Cornus florida flowering dogwood	1	
Vaccinium vacillans dryland blueberry	7	Shrubs
Vaccinium angustifolium laevifolium lowbush blueberry	6	
Gaylussacia baccata huckleberry	5	
Rhus radicans poison-ivy	5	
Rosa blanda meadow rose	5	
Arctostaphylos uva-ursi coactilis bearberry	4	
Ceanothus americanus New Jersey tea	4	
Opuntia compressa prickly-pear	4	
Parthenocissus quinquefolia Virginia creeper	4	
Prunus virginiana choke cherry	4	
Rhus copallina shining sumac	4	
Rubus sp. rasp- black- berry	4	
Smilax sp. greenbrier	4	

Table 3-40 continued

Vitis sp. wild grape	4	
Celastrus scandens bittersweet	3	
Diervilla lonicera bush honeysuckle	3	
Gaultheria procumbens wintergreen	3	
Hamamelis virginiana witch-hazel	3	
Lindera benzoin spicebush	3	
Rhus aromatica fragrant sumac	3	
Rubus hispidus dewberry	3	
Cornus stolonifera red-osier dogwood	2	
Crataegus sp. hawthorn	1	
Xanthoxylum americanum prickly ash	1	
Arabis lyrata rockcress	3	Herbs 22 Apr. 74
Phlox bifida cleft phlox	3	
Viola pedata birdfoot violet	2	
Viola soraria woolly blue violet	2	
Senecio aureus golden ragwort	1	
Pteridium aquilinum latiusculum bracken fern	6	29 May 74
Maianthemum canadense false lily-of-the-valley	5	
Lupinus perennis lupine	4	
Smilacina racemosa false Solomon's-seal	4	
Smilacina stellata starry false Solomon's-seal	4	
Aquilegia canadensis columbine	3	
Aralia nudicaulis wild sarsaparilla	3	
Botrychium virginianum rattlesnake fern	3	
Equisetum arvense field horsetail	3	

Table 3-40 continued

Erigeron philadelphicus common fleabane	3	
Fragaria virginiana strawberry	3	
Galium aparine cleavers	3	
Galium triflorum fragrant bedstraw	3	
Geranium maculatum wild geranium	3	
Medeola virginiana Indian cucumber-root	3	
Osmorhiza claytoni hairy sweet cicely	3	
Phlox bifida Cleft phlox	3	
Podophyllum peltatum May-apple	3	
Potentilla sp. Cinquefoil	3	
Ranunculus abortivus small-flowered buttercup	3	
Ranunculus recurvatus hooked buttercup	3	
Ranunculus sceleratus cursed buttercup	3	
Cardamine bulbosa bulb bittercress	2	
Cardamine pensylvanica Pennsylvania bittercress	2	
Krigia biflora two-flowered dwarf dandelion	2	
Polygonatum sp. Solomon's-seal	2	
Thalictrum sp. meadowrue	2	
Apocynum androsaemifolium spreading dogbane	1	
Carex pensylvanica Pennsylvania sedge	7	9 Aug. 74
Euphorbia corollata flowering spurge	5	
Koeleria cristata Junegrass	5	
Liatris aspera rough blazing-star	5	

Table 3-40 continued

Antennaira sp. pussytoes	4	
Aster linariifolius stiff aster	4	
Helianthus divaricatus woodland sunflower	4	
Tephrosia virginiana goat's-rue	4	
Agrimonia pubescens hairy agrimony	3	
Artemisia caudata wormwood	3	
Asclepias syriaca common milkweed	3	
Asclepias tuberosa butterfly-weed	3	
Asclepias verticillata whorled milkweed	3	
Aureolaria flava yellow false foxglove	3	
Aureolaria pedicularia fern-leaved false foxglove	3	
Campanula rotundifolia harebell	3	
Coreopsis tripteris tall coreopsis	3	
Galium circaezans wild licorice	3	
Galium pilosum hairy bedstraw	3	
Hieracium gronovii hairy hawkweed	3	
Lithospermum caroliniense hairy puccoon	3	
Monarda fistulosa wild bergamot	3	
Monarda punctata villicaulis horsemint	3	
Panicum sp. panic-grass	3	
Phlox pilosa downy phlox	3	
Poa compressa Canada bluegrass	3	
Rudbeckia hirta black-eyed Susan	3	
Tradescantia ohiensis common spiderwort	3	

Table 3-40 continued

Anemone cylindrica candle anemone	2	
Circaea quadrisulcata canadensis enchanter's nightshade	2	
Commelina erecta dayflower	2	
Desmodium sp. tick-trefoil	2	
Equisetum hyemale affine common scouring-rush	2	
Liatris cylindracea cylindric blazing-star	2	
Panicum virgatum switchgrass	2	
Solidago caesia blue-stemmed goldenrod	4	21 Sept. 74
Solidago uligonosa bog goldenrod	4	
Solidago nemoralis gray goldenrod	3	
Solidago speciosa showy goldenrod	3	
Aster azureus azure aster	2	
Aster linariifolius stiff aster	2	
Aster macrophyllus large-leaved aster	2	
Aster umbellatus flat-tooped white aster	2	
Lespedeza hirta hairy bush-clover	2	
Prenanthes alba white lettuce	2	
Solidago altissima tall goldenrod	1	

some 120 species for this stand--most of them with relatively low rankings--is a reflection in part of the extent of the stand but more importantly of the diversity of subhabitats within it. Dunes differ in age, differ in their orientation (south-facing slopes tend to be drier than north-facing ones), have different histories with respect to fire, etc. Olson (1958a, pp. 149-151) refers to some of the diverse combinations that may be found in black oak communities. We made no attempt to subdivide the stand and to describe such subdivisions, a task that would require considerable effort. But the following may be pointed out as examples of subhabitat differences: blackgum is important near the edges of marshy areas; starry false Solomon's-seal is more important where there is little humus in the substrate whereas common false Solomon's-seal is more important where there is considerable humus in the substrate; Junegrass, the blazing-stars, and the sunflowers are more important in the areas with open or sparse canopy whereas the false Solomon's-seals, harebell, and false lily-of-the-valley are more important in the areas with more closed canopy.

One portion of this stand which is noticeably lower in elevation and has a wetter than usual substrate--that immediately west of Mineral Springs Road at NE¼ NE¼ NE¼, section 22, T 37 N, R 6 W--was ranked separately. These rankings are presented in Table 3-41. Most conspicuous in this stand is the high ranking (5) of red maple. A number of the marshy pockets within the black oak stand were also studies; these data will be presented in the wetland section below.

The east portion of the Cowles Unit stand extends northeast from Mineral Springs Road on the west to Waverly Road on the east, is bounded by what is referred to as the Great Marsh on the south, and extends to national lakeshore boundary on the north. In most cases those parts of this stand coded F-1 on the land use map do not differ to any extent from the west portion of the Dune Acres stand ranked in Table 3-40 and therefore are not ranked separately. But there are a few places in which there is distinctive vegetation in the F-1 area, and it will be noted on the land use map that there are extensive areas coded F-2 and E-2 lying within the F-1 matrix; these require special notice.

The Dune Acres topographic map shows that there are three crescent-shaped ridges extending in a north-south direction through this eastern portion of the Cowles Unit stand: one to the west, one to the east, and the third about midway between them. Moreover, the westward extensions of these ridges to the south form a rather well defined ridge along the northern border of the Great Marsh. It is on these crescent-shaped ridges and their extensions--dunes of Algonquin age--that the vegetation is like that ranked in Table 3-40.

On the slope which extends downward to the Great Marsh and on the flat area along the northern edge of the Great Marsh the vegetation is considerably different than that on the ridges. The plants in this portion of the stand are ranked in Table 3-42. Though this portion is

Table 3-41. Stratum ranking of vegetation of forest stand in low area immediately west of Mineral Springs Road at Dune Acres--NE¼ SE¼ NE¼, section 22, T 37 N, R 6 W., Cowles Unit.

Quercus velutina black oak	8	Trees
Amelanchier sp. serviceberry	5	
Acer rubrum red maple	4	
Prunus serotina black cherry	4	
Quercus alba white oak	4	
Sassafras albidum sassafras	4	
Nyssa sylvatica blackgum	3	
Vaccinium angustifolium laevifolium lowbush blueberry	7	Shrubs
Vaccinium vacillans dryland blueberry	7	
Gaultheria procumbens wintergreen	5	
Gaylussacia baccata huckleberry	5	
Rosa blanda meadow rose	5	
Parthenocissus quinquefolia Virginia creeper	4	
Prunus virginiana choke cherry	4	
Rubus sp. rasp- black- berry	4	
Crataegus sp. hawthorn	3	
Rubus hispidus dewberry	3	
Sambucus canadensis common elder	3	
Smilax lasioneura carrion-flower	3	
Smilax sp. greenbrier	3	
Cornus stolonifera red-osier dogwood	2	
Hamamelis virginiana witch-hazel	2	

Table 3-41 continued

Rhus copallina shining sumac	2	
Rhus radicans poison-ivy	2	
Pteridium aquilinum latiusculum bracken fern	6	Herbs 9 Aug. 74
Agrimonia pubescens hairy agrimony	5	
Maianthemum canadense false lily-of-the-valley	5	
Solidago sp. goldenrod	5	
Aralia nudicaulis wild sarsaparilla	4	
Helianthus divaricatus woodland sunflower	4	
Monarda fistulosa wild bergamot	4	
Smilacina racemosa false Solomon's-seal	4	
Anemone cylindrica candle anemone	3	
Aquilegia canadensis columbine	3	
Circaea quadrisulcata canadensis enchanter's nightshade	3	
Cryptotaenia canadensis honewort	3	
Lupinus perennis lupine	3	
Osmunda cinnamomea cinnamon fern	3	
Achillea millefolium yarrow	2	
Apocynum androsaemifolium spreading dogbane	2	
Botrychium virginianum rattlesnake fern	2	
Osmorhiza claytoni hairy sweet cicely	2	
Onoclea sensibilis sensitive fern	2	
Polygonatum sp. Solomon's-seal	2	
Prunella vulgaris self-heal	2	
Smilacina stellata starry false Solomon's-seal	2	
Tephrosia virginiana goat's-rue	2	
Tradescantia ohiensis common spiderwort	2	
Galium circaezans wild licorice	1	

Table 3-42. Stratum ranking of plant species on slopes bordering Great Marsh to the north--NW¼ SE¼ NW¼, section 23, T 37 N, R 6 W., Cowles Unit.

Nyssa sylvatica blackgum	7	Trees	
Quercus alba white oak	7		
Acer rubrum red maple	6		
Sassafras albidum sassafras	6		
Prunus serotina black cherry	4		
Quercus rubra red oak	3		
Quercus velutina black oak	3		
Amelanchier sp. serviceberry	2		
Rubus sp. rasp- black- berry	6	Shrubs	
Aronia melanocarpa black chokeberry	4		
Rubus hispidus dewberry	4		
Vitis sp. wild grape	4		
Parthenocissus quinquefolia Virginia creeper	3		
Smilax sp. greenbrier	3		
Diervilla lonicera bush honeysuckle	2		
Symplocarpus foetidus skunk-cabbage	4	Herbs	26 Apr. 74
Caltha palustris marsh marigold	3		
Osmunda cinnamomea cinnamon fern	7		7 Aug. 74
Osmunda regalis spectabilis royal fern	4		
Aster ericoides heath aster	3		
Aster praealtus willow aster	3		
Maianthemum canadense false lily-of-the-valley	3		
Medeola virginiana Indiana cucumber-root	3		
Osmorhiza claytoni hairy sweet cicely	3		
Smilacina racemosa false Solomon's-seal	3		
Solidago altissima tall goldenrod	3		
Solidago juncea early goldenrod	3		
Hackelia virginiana stickseed	2		
Prenanthes alba white lettuce	2		

included in the F-1 area in the land use map and presented here for that reason, it could just as well (perhaps even more appropriately) be considered swamp forest and coded E-3 as will become apparent when that type of community is considered below. Blackgum, white oak, red maple, and sassafras are the dominant trees; black oak is of low importance (SR 3). Moreover, the black and white oaks of this portion of the stand are considerably larger both in diameter and in height than those in the adjoining ridges; these differences are undoubtedly attributable to the greater moisture in the substrate here. Black-raspberry is the most important plant in the shrub stratum. And cinnamon fern, a plant of wet substrates, is the most important herbaceous plant.

There is a path running north-south to the east of the western-most crescent-shaped dune and west of two small marshy areas at the center of NW¼, section 23, T 37 N, R 6 W. The plants in this portion of the stand are ranked in Table 3-43. Near the marshy areas the substrate is quite moist and here again an assemblage of plants is found which includes many characteristic of wet substrates; included among them are several species quite rare in this region: Virginia chainfern, trailing arbutus, and lily twayblade.

Lying in the depressions between the western and mid ridge and the mid and eastern ridge are two marshes (coded E-2) which will be described in the wetland section below. To the east of each of these marshes are rather large areas coded F-2. These are black oak dominated stands with a very sparse canopy, the ground cover of which includes a number of typical prairie species. Between the arms of these savannah type stands and between the stands and the marshes there are areas of open prairie. Because the vegetation of these two stands is so similar and because the herbaceous vegetation in the open areas differ little from that in the areas with scattered oak trees, all are ranked together in Table 3-44. The few species we found only in the western stand which lies beyond Lupine Lane (at NW¼ NE¼ NW¼, section 23, T 37 N, R 6 W) are marked L; those found only in the eastern stand which lies beyond Pine Lane (at SE¼ SW¼ SE¼, section 14, T 37 N, R 6 W) are marked P. We express our great appreciation to Mrs. Lois Howes of Dune Acres who pointed out to us many of the more unusual species of these two stands as well as of other stands in the Cowles Unit and who in general provided us with a great deal of information about the plant communities of Dune Acres, including Cowles Bog. Black oak, though sparse and in some areas absent and therefore ranked as 6, is the dominant tree species. Shrubs are of little importance. Junegrass is the most important herbaceous plant, and dense blazing-star and fern-leaved false foxglove are important associates. Goldenrods and asters are conspicuous in the fall, but several different species of each are present with no one of them with a high ranking.

Rattlesnake-master and wild indigo, typical prairie species, are quite common. A great many species with a rank of 1 or 2 are listed, a number of them--such as blue hearts, small woodland orchis, and running clubmoss--quite rare in this region.

Table 3-43. Stratum ranks of vegetation in portion of forest near marshy areas east of Mineral Springs Road at Dune Acres--at center of NW¼, section 23, T 37 N, R 6 W., Cowles Unit.

Quercus alba white oak	6	Trees
Quercus palustris pin oak	6	
Nyssa sylvatica blackgum	4	
Pinus banksiana jack pine	3	
Quercus velutina black oak	3	
Aronia melanocarpa black chokeberry	6	Shrubs
Rubus hispidus dewberry	5	
Vaccinium vacillans dryland blueberry	5	
Acer rubrum red maple	3	
Ilex verticillata winterberry	3	
Prunus virginiana choke cherry	3	
Vaccinium angustifolium laevifolium lowbush blueberry	3	
Chamaedaphne calyculata angustifolia leather-leaf	2	
Osmunda regalis spectabilis royal fern	6	Herbs
Scirpus cyperinus wool-grass	4	
Maianthemum canadense false lily-of-the-valley	3	
Polytrichum sp. hair-cap moss	3	
Pteridium aquilinum latiusculum bracken fern	3	
Sphagnum sp. peat-moss	3	
Thelypteris palustris pubescens marsh fern	3	
Hypericum canadense Canadian St.-John's-wort	2	
Rhynchospora capitellata clustered beakrush	2	
Woodwardia virginica Virginia chainfern	2	
Epigaea repens trailing arbutus	1	
Pyrola rotundifolia var. americana round-leaved pyrola	1	
Habenaria ciliaris orange fringed orchid	*	
Liparis liliifolia lily twayblade	*	
Lycopodium lucidulum shining clubmoss	*	

*Reported by Mrs. Lois Howes

able 3-44. Stratum ranks of plant species of prairie openings beyond Lupine Lane and Pine Lane in Dune Acres--NW¼ NE¼ NW¼, section 23, T 37 N, R 6 W and SE¼ SW¼ SE¼, section 14, T 37 N, R 6 W., Cowles Unit.

Quercus velutina black oak	6	Trees
Prunus serotina black cherry	4	
Quercus alba white oak	3	
Cornus florida flowering dogwood	1	
Arctostaphylos uva-ursi coactilis bearberry	3	Shrubs
Hypericum kalmianum Kalm's St.-John's-wort	3	
Opuntia compressa prickly-pear	3	
Hudsonia tomentosa false heather	1	L
Koeleria cristata Junegrass	7	Herbs 7 Aug. 74
Liatris spicata dense blazing-star	6	
Aureolaria pedicularia fern-leaved false foxglove	5	
Aletris farinosa star-grass	4	
Eryngium yuccifolium rattlesnake-master	4	
Euphorbia corollata flowering spurge	4	
Liatris aspera rough blazing-star	4	
Artemisia caudata wormwood	3	
Asclepias tuberosa butterfly-weed	3	
Aureolaria flava yellow false foxglove	3	
Baptisia leucantha wild-indigo	3	
Coreopsis tripteris tall coreopsis	3	
Helianthus divaricatus woodland sunflower	3	
Helianthus occidentalis western sunflower	3	

L - Beyond Lupin Lane only
P - Beyond Pine Lane only

Table 3-44 continued

Liatris cylindracea cylindric blazing-star	3	
Lupinus perennis lupine	3	
Monarda fistulosa wild bergamot	3	
Monarda punctata villicaulis horsemint	3	
Pedicularis canadensis lousewort	3	
Pteridium aquilinum latiusculum bracken fern	3	
Rudbeckia hirta black-eyed Susan	3	
Smilacina racemosa false Solomon's-seal	3	
Smilacina stellata starry false Solomon's-seal	3	
Tephrosia virginiana goat's-rue	3	
Tradescantia ohiensis common spiderwort	3	
Anemone cylindrica candle anemone	2	
Asclepias verticillata whorled milkweed	2	
Galium pilosum hairy bedstraw	2	
Hieracium gronovii hairy hawkweed	2	
Hypericum punctatum spotted St.-John's-wort	2	
Lysimachia lanceolata lance-leaved loosestrife	2	
Polygala cruciata aquilonia marsh milkwort	2	
Pycnanthemum tenuifolium slender mountain-mint	2	
Stachys hyssopifolia hyssop hedge-nettle	2	
Xyris caroliniana yellow-eyed grass	2	
Asclepias amplexicaulis blunt-leaved milkweed	1	
Bartonia virginica screwstem	1	L
Buchnera americana blue-hearts	1	P

L - Beyond Lupin Lane only
P - Beyond Pine Lane only

Table 3-44 continued

Castilleja coccinea Indian paintbrush	1	
Habenaria clavellata small green fringed orchid	1	L
Helianthemum canadense frostweed	1	L
Hypericum canadense Canadian St.-John's-wort	1	
Krigia virginica Virginia dwarf dandelion	1	
Lilium philadelphicum var. andinum wood lily	1	L
Lycopodium clavatum running clubmoss	1	L
Rhexia virginica meadow-beauty	1	L
Aster azureus azure aster	3	21 Sept. 74
Aster dumosus bushy aster	3	
Aster linariifolius stiff aster	3	
Solidago graminifolia grass-leaved goldenrod	3	
Solidago juncea early goldenrod	3	
Solidago speciosa showy goldenrod	3	
Solidago racemosa gillmani dune goldenrod	3	
Solidago gymnospermoides lance-leaved goldenrod	3	
Thelypteris palustris pubescens marsh fern	3	
Aster novae-angliae New England aster	2	
Aster vimineus small white aster	2	
Coreopsis palmata stiff coreopsis	2	P
Fragaria virginiana strawberry	2	
Gentiana crinita fringed gentian	2	
Gentiana saponaria soapwort gentian	2	P

L - Beyond Lupin Lane only
P - Beyond Pine Lane only

Table 3-44 continued

Gerardia purpurea purple gerardia	2	L
Lechea tenuifolia narrow-leaved pinweed	2	L
Polygonum coccineum swamp smartweed	2	P
Prenanthes racemosa smooth white lettuce	2	
Solidago altissima tall goldenrod	2	
Solidago nemoralis gray goldenrod	2	
Spiranthes lacera slender ladies'-tresses	2	
Cacalia atriplicifolia Indian plantain	1	P
Polygonum tenue slender knotweed	1	P
Sabatia angularis rose-pink	1	P
Veronia altissima ironweed	1	P
Carex retrorsa turned-backward sedge	*	
Corallorhiza maculata spotted coralroot	*	
Corallorhiza odontorhiza late coralroot	*	
Echinochloa crusgalli barnyard grass	*	
Gentiana flavida yellowish gentian	*	
Habenaria flava herbiola tubercled orchid	*	
Habenaria lacera ragged fringed orchid	*	
Lycopodium lucidulum shining clubmoss	*	
Melampyrum lineare latifolium cow-wheat	*	
Orobanche fasciculata clustered cancer-root	*	
Spiranthes cernua nodding ladies'-tresses	*	
Stipa spartea porcupine grass	*	

L - Beyond Lupin Lane only
P - Beyond Pine Lane only
* - Reported by Mrs. Lois Howes

The black oak stand of the East Unit, developed on sand of the Tolleston-Algonquin dune complex, extends from Kemil Road on the West to Mount Baldy on the East, and from the foredunes (many of them eroded away) on the north to Beverly Drive on the south. There are roads and houses scattered through most of this stand, and for that reason most of it is coded H-1 on the land use maps. But in many places the woods are remarkably natural in appearance, and in the westernmost part the roadsare now closed off and in the easternmost part there never were roads. The vegetation of the least disturbed easternmost part of this stand (that portion immediately west of the Mount Baldy blowout complex) is ranked in Table 3-45. Black oak is the dominant tree species and forms a closed canopy as the F-1 coding indicates. White oak (SR 4) is the only one of the remaining six tree species of much importance. Dryland blueberry is the dominant shrub. Starry false Solomon's-seal and bracken fern, particularly noticeable in the summer, are the most important herbaceous plants. Flowering spurge and Pennsylvania sedge, which have regularly been listed above as important species, are next in ranking; strawberry has an equal ranking in this community. Other parts of the stand appear to be very similar to this except in a few cases. In the wooded area at the end of Windsor Place and along the roadside nearby (at SE¼ SW¼ SW¼, section 4, T 37 N, R 5 W) were found hepatica, bellwort, and honesty (Lunaria rediviva); the latter is undoubtedly an escapee, and it seems quite likely that the other species were transplanted by persons living in the area. The other exception is a more natural one. Behind and to the west of the blowout complex at the end of Central Avenue (at NE¼ NE¼ SE¼, section 35, T 38 N, R 5 W), there appears to be continued sand movement and infiltration, and the communities in these unstable areas are a bit more complex than elsewhere. Specifically, in a western pocket there is a stand of large white pine. Where the forest abuts the active dune basswood and hoptree are important. Within the forest in this vicinity are common juniper, bearberry, bittersweet, southern panic-grass (Panicum meridionale), false lily-of-the-valley, hepatica, and thin-leaved coneflower (Rudbeckia triloba); many of these species are characteristic of pine dunes.

Invertebrates have been collected from several of these black oak forest stands. Table 3-46A lists the forms collected by Ecological Services of Texas Instruments Incorporated from the black oak forest which lies east of the NIPSCO power plant; the location in which they collected, immediately behind the foredunes, is in a relatively young portion of the stand. In Table 3-47B are listed the forms Ecological Services collected from that portion of the same black oak forest which lies west of Cowles Bog; lying half a mile behind the foredunes, this portion is considerably more mature. In Table 3-48A are listed the forms we collected in 1980 from the stand which lies east of County Line Road and south of U.S. 12; this stand, though developed on Tolleston-Algonquin substrates and thus far older than previous two, has a relatively open canopy. Table 3-49A lists the forms we collected in 1980 from the mesophytic pocket in the stand northwest of Long Lake.

Table 3-45. Stratum ranks of plant species of forest west of Mount Baldy--SE¼ NE¼ NE¼, section 36, T 38 N, R 5 W., East Unit.

Quercus velutina black oak	8	Trees
Quercus alba white oak	4	
Amelanchier sp. serviceberry	2	
Cornus florida flowering dogwood	2	
Prunus serotina black cherry	2	
Sassafras albidum sassafras	2	
Nyssa sylvatica blackgum	1	
Vaccinium vacillans dryland blueberry	6	Shrubs
Rosa blanda meadow rose	4	
Smilax sp. greenbrier	4	
Vitis sp. wild grape	4	
Hamamelis virginiana witch-hazel	3	
Parthenocissus quinquefolia Virginia creeper	3	
Prunus virginiana choke cherry	3	
Rhus radicans poison-ivy	3	
Viburnum acerifolium mapleleaf viburnum	3	
Berberis thunbergii Japanese barberry	1	
Arabis lyrata rockcress	3	Herbs 1 May 74
Viola primulifolia primrose-leaved violet	1	
Aquilegia canadensis columbine	3	30 May 74
Smilacina racemosa false Soloman's-seal	3	
Apocynum androsaemifolium spreading dogbane	2	
Aralia nudicaulis wild sarsaparilla	2	
Potentilla sp. cinquefoil	1	
Tephrosia virginiana goat's-rue	1	
Tradescantia ohiensis common spiderwort	1	
Aster azureus azure aster	3	4 Oct. 74
Solidago caesia blue-stemmed goldenrod	3	
Solidago nemoralis gray goldenrod	3	
Prenanthes alba white lettuce	2	
Kuhnia eupatorioides corymbulosa false boneset	1	
Lespedeza hirta hairy bush-clover	1	

Table 3-45 continued

Galium circaezans wild licorice	2	
Polygonatum sp. Solomon's-seal	2	
Smilacina stellata starry false Solomon's-seal	6	3 July 74
Pteridium aquilinum latiusculum bracken fern	5	
Carex pensylvanica Pennsylvania sedge	4	
Euphorbia corollata flowering spurge	4	
Fragaria virginiana strawberry	4	
Anemone cylindrica candle anemone	3	
Galium pilosum hairy bedstraw	3	
Helianthus divaricatus woodland sunflower	3	
Monarda punctata villicaulis horsemint	3	
Poa sp. bluegrass	3	
Rudbeckia hirta black-eyed Susan	3	
Agrimonia pubescens hairy agrimony	2	
Antennaria sp. pussytoes	2	
Asclepias tuberosa butterfly-weed	2	
Aureolaria pedicularia fern-leaved false foxglove	2	
Campanula rotundifolia harebell	2	
Hieracium gronovii hairy hawkweed	2	
Monarda fistulosa wild bergamot	2	
Oenothera biennis evening-primrose	2	
Panicum sp. panic-grass	2	
Liatris aspera rough blazing-star	1	
Osmorhiza claytoni hairy sweet cicely	1	

Table 3-46A Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from immature black oak forest east of Bailly generating station--SW¼ SE¼ NW¼, section 21, T 37 N, R 6 W. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).

	1974	1975	1976	1977	1978	1979
COLLEMBOLA						
Poduridae					x	x
Isotomidae	x	x	x		x	x
Onychiuridae		x				
Entomobryidae	x					x
Sminthuridae	x					
ODONATA						
Aeschinidae		x				
Libellulidae		x				
Coenagrionidae		x				
Enallagma sp.		x	x			
Ischnura sp.				x		
Nehalennia sp.				x		
ORTHOPTERA						
Acrididae	x					
Tetigoniidae						
Microcentrum sp.			x			
Gryllidae						
Gryllus sp.	x					
Phasmatidae		x	x			
Diapheromera femorata					x	x
Blattidae	x					
PLECOPTERA						
Isoperlidae						
Isoperla sp.	x	x				
PSOCOPTERA						
Liposcelidae		x				
THYSANOPTERA						
Phloeothripidae	x	x		x		
Thripidae	x	x				
HEMIPTERA						
Nepidae		x				
Miridae		x			x	
Dereocoris sp.		x				
Eustictus sp.				x		
Lygus lineolaris	x					
Nabidae						
Nabis sp.			x	x		
Phymatidae						
Phymata sp.			x			
Tingidae						
Corythuca sp.	x					
C. contracta		x		x		
Coreidae		x				
Pentatomidae		x		x		
Acrosternum sp.	x					
Cosmopepla bimaculata				x	x	
HOMOPTERA						
Membracidae	x					
Crytolobus sp.					x	x
Ophiderma sp.						x

Table 3-46A continued

	1974	1975	1976	1977	1978	1979
HOMOPTERA-Cont.						
Cicadidae		x				
Cicadellidae	x	x	x	x		x
Agallia constricta	x					
Chlorotettix Sp.					x	
Dikraneura Sp.				x		
Empoasca Sp.						x
Graphocephala Sp.			x		x	x
Mesamia Sp.					x	
Cercopidae	x	x	x	x	x	x
Delphacidae		x				
Cixiidae				x		
Achilidae	x			x		
Acanaloniidae		x		x		
Issidae		x				
Psyllidae				x		
Aphididae	x	x	x			x
COLEOPTERA						
Cupedidae						
Cupes concolor					x	
Carabidae						
Lema pumila					x	
Tachys						x
Hydrophilidae						
Helophrus					x	
Staphylinidae	x	x				
Gyrophaena Sp.	x					
Tachinus Sp.	x					
Pselaphidae	x				x	
Orthoperidae						
Artholips Sp.	x					
Cantnaridae						
Cantharis Sp.	x					
Podabrus Sp.	x	x				
Lampyridae						
Photinus Sp.		x	x			
Dermestidae	x					
Malachiidae						
Attalus Sp.		x				
A. terminalis						x
Cleridae						
Phyllobaenus Sp.		x		x		
P. pallipennis			x		x	x
Phalacridae						
Olibrus Sp.				x		
Elateridae		x	x			
Athous Sp.						x
Melanotus Sp.	x					
Buprestidae						
Brachys Sp.	x					
Helodidae						
Cyphon Sp.	x					
Scrites Sp.					x	
Cryptophagidae	x					
Nitidulidae		x				

Table 3-46A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-Cont.						
Lathridiidae						
Corticaria Sp.	x					
Coccinellidae						
Adalia bipunctata	x				x	
Anatis 15-punctata						x
Cycloneda munda	x					
Hippodamia convergens			x			
Hyperaspis undulata		x				
Psyllobora virginitimaculata	x					
Pyrochroidae						
Dendroides Sp.		x				
Mordellidae	x					
Alleculidae						
Isomira sericea			x		x	
Tenebrionidae						
Xylopinus Sp.				x		
Melandryidae	x					
Symphora Sp.		x			x	x
Scarabaeidae						
Phyllophaga Sp.	x	x				
Serica Sp.	x					
Curculionidae	x	x	x		x	x
Scolytidae	x					
Chrysomelidae						
Altica Sp.	x				x	
Babia Sp.		x				
Chaetocnema minuta	x	x				
Chalmisus Sp.					x	
Dibolia Sp.		x				
Diabrotica virgifera				x		
Nodonota Sp.						x
Phyllotreta Sp.	x					
NEUROPTERA						
Chrysopidae	x		x	x	x	x
Hemerobiidae	x			x		
Myrmeliontidae		x				
TRICHOPTERA						
Hydroptilidae	x					
Leptoceridae	x					
Oecetis Sp.				x		
Phryganeidae	x					
Banksiola selina					x	
Limnephilidae	x					
LEPIDOPTERA						
Papilionidae						
Papilio polyxenes						x
Pieridae						
Pieris rapae					x	
P. protodice				x		
Nymphalidae						
Cynthia cardui				x		
Satyridae						
Euptychia cymela			x	x		

Table 3-46A continued

	1974	1975	1976	1977	1978	1979
LEPIDOPTERA-Cont.						
Lycaenidae						
Lycaenopsis argiolus		x				
Saturniidae						
Anthaerea polyphemus					x	
Arctiidae						
Estigmene congrua	x					
Halisodota tesselaris	x	x				x
Hypoprepia fucosa				x		x
H. miniata		x				
Noctuidae	x	x				
Epizeuxis aemula					x	
Melipotis Sp.						x
Phosphila miseliodes					x	
Ulolanche culea				x		
Zale Sp.					x	
Geometridae		x				
Lygris diversilineata					x	
Sabulodes thisoaria		x				
Pyralidae		x				
Sesmia funeralis			x			
Herculia himonialis					x	
Pantographa limata			x			
Micromoths		x	x	x	x	x
DIPTERA						
Tipulidae	x	x	x	x		
Chaoboridae	x			x		
Chironomidae	x	x	x	x	x	x
Culicidae	x	x	x	x	x	x
Mycetophilidae	x					
Sciaridae	x	x	x		x	x
Cecidomyiidae		x		x		
Ceratopogonidae	x	x				
Stratiomyiidae						
Ptecticus Sp.					x	
Tabanidae						
Chrysops		x				
C. vittatus					x	
Threvidae				x		
Asilidae		x				
Leptogaster annulatus					x	
Lonchopteridae						
Lonchoptera Sp.	x	x	x			x
Phoridae		x				x
Empididae	x	x	x	x		
Hybos Sp.					x	x
Tachypeza Sp.						
Dolichopodidae	x	x				
Chrysotus Sp.			x	x		x
Condylostylus Sp.				x		x
Gymnoternus Sp.			x			
Thinophilus Sp.				x		
Pipunculidae	x					
Sepsidae		x				
Lauxaniidae	x					
Camptoprosopella Sp.			x			
Sapromyza Sp.			x		x	

Table 3-46A continued

	1974	1975	1976	1977	1978	1979
DIPTERA-Cont.						
Piophilidae		x				x
Sphaeroceridae	x	x				
Leptocera Sp.						x
Scatophora Sp.						
Ephydridae	x					
Dichaeta Sp.				x		
Drosophilidae'	x	x	x			
Chymomyza Sp.					x	
Chloropidae	x	x				
Hippelates Sp.			x			
Anthomyiidae	x	x				
Heleomycidae		x				
Calliphoridae	x	x				
Muscidae	x	x			x	x
Tenthredinidae		x				
Braconidae	x		x	x	x	x
Ichneumonidae	x	x	x	x	x	x
Torymidae	x	x				
Pteromalidae	x		x			
Eurytomidae		x				
Evaniidae		x				
Chalcididae				x		
Cynipidae	x	x	x			
Formicidae	x	x	x	x	x	x
Sphecidae				x		x
Apidae						
Apis mellifera	x	x			x	
Xylocopa Sp.	x					
PSEUDOSCORPIONIDA	x				x	
PHALANGIDA			x	x	x	x
ACARINA	x	x	x		x	x
ARANEIDA	x	x	x	x	x	x
CLASS DIPLOPODA					x	
CLASS CHILOPODA	x					

Table 3-46B. Invertebrates collected in four of six sample years from immature black oak forest east of Bailly generating station.

COLLEMBOLA--springtails
- Isotomidae

HEMIPTERA
- Pentatomidae--stink bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Aphididae--plantlice

COLEOPTERA
- Cleridae--checkered beetles
- Elateridae--click beetles
- Coccinellidae--ladybird beetles
- Melandryidae--false darkling beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles

NEUROPTERA
- Chrysopidae--common lacewings

LEPIDOPTERA
- Arctiidae--tiger moths
- Noctuidae--miller moths
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chironomidae--midges
- Culicidae--mosquitoes
- Sciaridae--dark-winged fungus gnats
- Lonchopteridae--spear-winged flies
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Drosophilidae--small fruit flies
- Muscidae--muscid flies

HYMENOPTERA
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps
- Formicidae--ants

PHALANGIDA--daddy-long-legs

ACARINA--mites

ARANEIDA--spiders

Table 3-46C. Trophic levels of invertebrates collected in four of six sample years from immature black oak forest east of Bailly generating station.

HERBIVORES
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Aphididae--plantlice
- Elateridae--click beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles
- Arctiidae--tiger moths
- Noctuidae--miller moths
- Micromoths

PREDATORS
- Cleridae--checkered beetles
- Coccinellidae--ladybird beetles
- Chrysopidae--common lacewings
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Chironomidae--midges

PARASITES
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps

Table 3-47A. Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from mature black oak forest west of Cowles Bog--center of W margin of NW¼ SE¼, section 22, T 37 N, R 6 W. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).

	1974	1975	1976	1977	1978	1979
PROTURA	x				x	
COLLEMBOLA						
Poduridae		x				
Isotomidae	x	x	x		x	x
Entomobryidae	x				x	x
Sminthuridae					x	x
						x
ODONATA						
Libellulidae	x	x				
Sympetrum vicinium			x			x
Coenagrionidae	x	x				
Enallagma sp.		x				
Nehalennia sp.			x			
Lestidae	x	x				
Lestes rectangularis			x		x	
ORTHOPTERA						
Acrididae					x	x
Tetigoniidae	x	x	x			
Blattidae		x				
PSOCOPTERA						
Psocidae	x			x		
Pseudocaeciliidae	x				x	
Polysocidae	x	x		x		
THYSANOPTERA						
Phloeothripidae	x	x				
HEMIPTERA						
Corixidae						
Sigara sp.					x	
Miridae	x	x				
Hyaliodes sp.		x				
Lygus lineolaris	x				x	
Trigonotylus tarsalis					x	x
Nabidae				x		
Nabis sp.						
Reduviidae	x					
Zelus sp.				x	x	x
Tingidae						
Corythuca	x				x	
C. arcuata				x		x
C. contracta	x	x				
Lygaeidae						
Ischnorhynchus resedae	x	x				
Oedancala sp.						x
Berytidae						
Jalysus sp.	x					
Pentatomidae	x					
Cosmopepla bimaculata						x
Mormidae lugens					x	

Table 3-47A continued

	1974	1975	1976	1977	1978	1979
HEMIPTERA-Cont..						
Cydnidae	x					
HOMOPTERA						
Membracidae	x					
Cyrtolobus sp.					x	x
Ophiderma sp.						x
Cicadellidae	x	x	x		x	
Chlorotettix sp.				x		x
Cloanthanus sp.						x
Dikraneura sp.				x		
Flexamia sp.					x	
Palus sp.						x
Paraphlepsius sp.						x
Cercopidae	x	x	x	x	x	x
Delphacidae	x	x				
Achilidae	x	x			x	x
Flatidae	x					x
Acanaloniidae	x					
Aphididae	x	x	x		x	x
COLEOPTERA						
Carabidae	x					
Lebia viridis			x			
Ptiliidae						
Ptinella sp.	x		x		x	x
Staphylinidae	x	x	x		x	x
Gyrophaena sp.	x					
Pselaphidae	x					
Silphidae						
Nicrophorus sayi						x
Cantharidae					x	
Cantharis sp.	x		x			
C. rectus				x	x	x
Lampyridae						
Ellychnia corrusca	x	x				
Photinus sp.		x	x			
Cleridae						
Phyllobaenus sp.				x		x
Elateridae	x					
Limonius basillaris	x	x	x			
Melanotus sp.	x					
Buprestidae						
Agrilus arcuatus		x				
Brachys aerosus						x
Taphocerus sp.		x				
Helodidae						
Cyphon sp.	x	x		x	x	x
Prionocyphon sp.			x			
Scrites sp.		x	x	x		x
Cryptophagidae						
Paraxontha sp.	x					

Table 3-47A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-Cont.						
Coccinellidae						
Cycloneda munda	x					
Microweisea sp.	x					
Psyllobora virginitimaculata	x	x				
Scymnus sp.	x	x	x			
Pedilidae					x	
Mordellidae						
Mordella sp					x	
Alleculidae						
Isomira sericea			x			
Tenebrionidae						
Uloma imberbis		x				
Melandryidae						
Canifa sp.	x		x			x
Anobiidae	x					
Cerambycidae						
Psyrassa unicolor			x			
Curculionidae	x	x	x		x	
Scolytidae	x				x	
Chrysomelidae						
Altica sp.	x					
Chaetocnema minuta	x					
Chalmisus sp.				x		
Chrysodina sp.					x	
Nodonota sp.					x	
Phyllotreta	x					
NEUROPTERA						
Chrysopidae	x				x	x
Hemerobiidae	x	x			x	x
TRICHOPTERA						
Limnephilidae	x					
LEPIDOPTERA						
Papilionidae						
Papilio polyxenes				x		
Pieridae						
Pieris rapae						x
Nymphalidae						
Cynthia cardui				x		
Junonia coenia					x	
Phyciodes tharos					x	
Speyeria cybele					x	
Satyridae						
Euptychia mitchelli		x				
E. cymela			x	x	x	x
Lethe eurydice					x	x
L. portlandia					x	
Lycaenidae						
Everes comyntas						x
Lycaenopsis argiolus				x	x	x
Satyricum caryaevorus					x	x
Saturniidae						
Anthaerea polyphemus					x	
Arctiidae						
Halisodota tesselaris						x

Table 3-47A continued

	1974	1975	1976	1977	1978	1979
LEPIDOPTERA-Cont.						
Hypoprepia fucosa						x
Noctuidae						
Mamestra vicina						x
Melipotis sp.						x
Geometridae	x	x		x		
Pyralidae	x	x				
Desmia funeralis			x			
Micromoths			x	x	x	x
DIPTERA						
Tipulidae	x	x	x	x	x	x
Ptychopteridae						
Bittacomorpha clavipes					x	x
Chaoboridae	x	x		x	x	x
Chironomidae	x	x	x	x	x	x
Dixiidae					x	
Bibionidae	x					
Bibio sp.				x		
Culicidae	x	x	x	x	x	x
Mycetophilidae	x					
Sciaridae		x	x		x	
Scatopsidae		x				
Cecidomyiidae					x	
Ceratopogonidae	x	x	x		x	x
Stratiomyiidae					x	
Pedicella sp.					x	
Ptecticus sp.			x			
Tabanidae	x					
Chrysops sp.	x	x				
C. cincticornis						x
C. cuclux			x			
C. vittatus		x	x	x	x	x
Threvidae					x	
Empididae	x	x				
Hybos sp.					x	x
Tachypeza sp.					x	x
Dolichopodidae	x	x				
Argyra sp.			x			
Chrysotus sp.			x	x	x	x
Dolichopus sp.					x	
Gymnoternus sp.			x			x
Pelastoneurus sp.			x			
Sciaphus sp.						x
Thinophilus sp.			x			x
Pipunculidae	x					
Alloneura sp.			x			
Rhagionidae	x					
Syrphidae	x	x				
Tephritidae					x	
Sepsidae	x	x				
Spesis sp.			x			x
Lauxaniidae	x	x				
Sapromyza sp.			x		x	x
Piophilidae		x			x	x

Table 3-47A continued

	1974	1975	1976	1977	1978	1979
DIPTERA-Cont.						
Sphaeroceridae	x	x				
Scatophora sp.			x			
Ephydridae			x			
Dichaeta sp.			x			
Pahydra sp.			x			
Scatophila sp.			x			
Drosophilidae	x	x				
Chymomyza sp.				x		
Chloropidae	x	x				
Cetema sp.			x			
Parectocephala sp.			x			
Agromyzidae		x				
Anthomyiidae	x	x				
Clusiidae	x	x				
Lonchaeidae		x				
Calliphoridae	x					
Muscidae	x	x	x		x	x
Tachinidae			x			
HYMENOPTERA						
Pergidae						
Acordulecera sp.	x					
Argidae			x			
Tenthredinidae	x	x	x	x		
Braconidae	x	x		x	x	
Ichneumonidae	x	x	x	x	x	
Eulophidae			x		x	
Pteromalidae	x					
Eurytomidae	x					
Evaniidae					x	
Chalcididae						x
Cynipidae				x		
Tiphiidae		x				
Formicidae	x	x	x	x	x	x
Sphecidae		x		x		
Andrenidae						x
Apidae						
Apis mellifera	x	x			x	x
Xylocopa sp.	x					
PSEUDOSCORPIONIDA	x	x			x	
PHALANGIDA				x	x	x
ACARINA	x	x	x		x	x
ARANEIDA	x	x	x	x	x	x
CLASS DIPLOPODA					x	

Table 3-47B. Invertebrates collected in four of six sample years from mature black oak forest northwest of Cowles Bog.

COLLEMBOLA--springtails
- Isotomidae

ODONATA
- Lestidae--spread-winged damselflies

HEMIPTERA
- Miridae--plant bugs
- Reduviidae--assassin bugs
- Tingidae--lace bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Achilidae--planthoppers
- Aphididae--plantlice

COLEOPTERA
- Ptiliidae--feather-winged beetles
- Staphylinidae--rove beetles
- Cantharidae--soldier beetles
- Helodidae--marsh beetles
- Curculionidae--snout beetles

NEUROPTERA
- Hemerobiidae--brown lacewings

LEPIDOPTERA
- Satyridae--satyrs
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chaoboridae--phantom midges
- Chironomidae--midges
- Culicidae--mosquitoes
- Ceratopogonidae--biting midges
- Tabanidae--horse/deer flies
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Sepsidae--black scavenger flies
- Lauxaniidae--lauxaniids
- Muscidae--muscid flies

HYMENOPTERA
- Tenthredinidae--common sawflies
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps
- Formicidae--ants
- Apidae--bumble/honey bees

ACARINA

ARANEIDA

Table 3-47C. Trophic levels of invertebrates collected in four of six sample years from mature black oak forest northwest of Cowles Bog.

HERBIVORES
- Miridae--plant bugs
- Tingidae--lace bugs
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Achilidae--planthoppers
- Aphididae--plantlice
- Curculionidae--snout beetles
- Satyridae--satyrs
- Micromoths
- Tenthredinidae--common sawflies
- Apidae--bumble/honey bees

PREDATORS
- Lestidae--spread-winged damselflies
- Reduviidae--assassin bugs
- Staphylinidae--rove beetles
- Hemerobiidae--brown lacewings
- Chaoboridae--phantom midges
- Empididae--dance flies
- Colichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Ptiliidae--feather-winged beetles
- Chironomidae--midges
- Sepsidae--black scavenger flies

PARASITES
- Ceratopogonidae--biting midges
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps

Table 3-48A. Invertebrates taken in samples collected July 24, 1980, from open-canopied black oak forest south of U. S. 12 and east of County Line Road--center of S½ SE¼, section 34, T 37 N, R 7 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
DIPLURA			
Campodeidae			2
COLLEMBOLA			
Poduridae			2
Isotomidae			3
Onychiuridae			4
Entomobryidae			2
Sminthuridae			2
ODONATA			
Libellulidae			
Sympetrum sp.	1		
Coenagrionidae			
Nehalennia sp.	1		
Lestidae			
Lestes rectangularis		2	
ORTHOPTERA			
Acrididae	2	2	
Melanoplus sp.	4		
Tetigoniidae	2		
Scudderia furcata	1		
Phasmatidae			
Diapheromera femorata	2		
ISOPTERA			
Rhinotermitidae			2
THYSANOPTERA			
Phloeothripidae			2
HEMIPTERA			
Berytidae			
Jalysus sp.	1		
Pentatomidae			
Mormidae lugens	3	1	
HOMOPTERA			
Membracidae	2		
Cicadellidae			
Chlorotettix sp.	2		
Empoasca sp.		1	
Dictyopharidae	1		
Scolops sp.	2		
COLEOPTERA			
Lampyridae			
Lucidota sp.	1		
Elateridae			1
Helodidae			
Cyphon sp.		1	
Scirtes sp.	3		

Table 3-48A continued

	netting/ sweeping	light traps	from litter
COLEOPTERA-Cont.			
Coccinellidae	1		
Mordellidae			
Mordella sp.	1		
Chrysomelidae			
Trirhabda virgata	4		
Microrhopala sp.	2		
Curculionidae	2		
TRICHOPTERA			
Leptoceridae		1	
LEPIDOPTERA			
Noctuidae			
Apatela sp.	1		
Calpe canadensis		2	
Renia sp.		2	
Geometridae			
Ectropis crepuscularia		1	
Pyralidae			
Nymphula sp.		2	
Micromoths	3	2	
DIPTERA			
Tipulidae	4	3	
Psychodidae			1
Chaoboridae		3	
Chironomidae	3	4	
Culicidae		4	
Cecidomyiidae		2	
Tabanidae			
Chrysops sp.	1		
Phoridae			2
Empididae			
Hybos sp.	2		
Syndas sp.	3		
Dolichopodidae		1	
Gymnoternus sp.	1		
Mesorhaga sp.	2		
Sciaphus sp.	2		
Pipunculidae	2		
Syrphidae	1		
Otitidae			
Amphicnephes sp.	1		
Platystomatidae			
Rivellia sp.	4		
Sepsidae			
Sepsis sp.	1		
Chloropidae	1		
Calliphoridae	3		
Muscidae	1	1	
HYMENOPTERA			
Braconidae	2	1	
Ichneumonidae	3		
Pteromalidae	2		
Eurytomidae	1		
Tiphiidae	2		
Formicidae	3		2
PHALANGIDA	1		
ACARINA			4
ARANEIDA	3		2
CLASS DIPLOPODA			3

Table 3-48B. Invertebrates taken in abundance from open-canopied black oak forest south of U. S. 12 and east of County Line Road.

COLLEMBOLA--springtails
- Isotomidae
- Onychiuridae

ORTHOPTERA
- Acrididae--short-horned grasshoppers
- Tetigoniidae

HEMIPTERA
- Pentatomidae

HOMOPTERA
- Cicadellidae--leafhoppers
- Dictyopharidae--planthoppers

COLEOPTERA
- Helodidae--marsh beetles
- Chrysomelidae--leaf beetles

LEPIDOPTERA
- Noctuidae--miller moths
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chaoboridae--phantom midges
- Chironomidae--midges
- Culicidae--mosquitoes
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Platystomatidae--picture-winged flies
- Calliphoridae--blow flies

HYMENOPTERA
- Ichneumonidae--ichneumon wasps
- Formicidae--ants

ACARINA--mites

ARANEIDA--spiders

DIPLOPODA--millipeds

Table 3-48C. Trophic levels of invertebrates collected in abundance from open-canopied black oak forest south of U. S. 12 and east of County Line Road.

HERBIVORES
- Acrididae--short-horned grasshoppers
- Tetigoniidae--long-horned grasshoppers
- Cicadellidae--leafhoppers
- Dictyopharidae--planthoppers
- Chrysomelidae--leaf beetles
- Noctuidae--miller moths
- Micromoths

PREDATORS
- Chaoboridae--phantom midges
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Onychiuridae--springtails
- Chironomidae--midges
- Calliphoridae--blow flies
- Diplopoda--millipeds

PARASITES
- Ichneumonidae--ichneumon wasps

Table 3-49A. Invertebrates taken in samples collected July 24, 1980, from mesophytic pocket of black oak forest northwest of Long Lake--E½ NE¼ NW¼, section 34, T 37 N, R 7 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
COLLEMBOLA			
Poduridae			2
Isotomidae			4
Onychiuridae			2
Sminthuridae			1
ORTHOPTERA			
Gryllacrididae	1		
HEMIPTERA			
Nabidae			
Nabis sp.	3		
Phymatidae			
Phymata sp.	2		
HOMOPTERA			
Cicadellidae			
Empoasca sp.		3	
Erythroneura sp.		2	
Scophoideus sp.	2	2	
Acanaloniidae	2	1	
COLEOPTERA			
Cantharidae			
Cantharis sp.	2		
Lampyridae			
Photuris pennsylvanica		2	
Elateridae			3
Athous sp.		1	
Limonius sp.	1		
Helodidae			
Cyphon sp.		2	
Scirtes sp.		2	
Cucujidae			
Laemopholeus sp.		1	
Nitidulidae			
Lpuraea sp.			2
Anobiidae	2		
NEUROPTERA			
Chrysopidae		2	
Myrmeliontidae		2	
TRICHOPTERA			
Hydropsychidae		2	
LEPIDOPTERA			
Noctuidae	1		
Apatela sp.		2	
Epizeuxis aemula		3	
Mamestra sp.		2	
Pangrapta sp.		1	

Table 3-49A continued

	netting/ sweeping	light traps	from litter
LEPIDOPTERA-Cont.			
Geometridae	2		
Eustroma diversilineata		2	
Pyralidae			
Herculia himonialis		1	
Micromoths		3	
DIPTERA			
Tipulidae	2	3	
Psychodidae		3	
Chaoboridae		4	
Chironomidae	1	4	
Culicidae		4	
Sciaridae		2	
Cecidomyiidae		3	
Phoridae	1	2	
Dolichopodidae			
Dolichopus sp.	1		
Syndas sp.	2		
Lauxaniidae			
Homoneura sp.	2	1	
Sphaeroceridae	1		
Heleomyzidae	2		
Calliphoridae	1		
Muscidae	2	1	
Scopeuma sp.	1		
HYMENOPTERA			
Braconidae	2		
Ichneumonidae	2		
Formicidae	3		3
PSEUDOSCORPIONIDA			3
PHALANGIDA	1		
ACARINA			4
ARANEIDA	3	2	3
CLASS CHILOPODA			1

In the tables in which the invertebrates we collected are listed the columns and numbers indicate: a) the technique by which the specimens were taken; and b) the relative number taken of each form (1 = one; 2 = few; 3 = many; 4 = very many).

Following the procedure adopted above (see pages 3-119, 3-126) in Tables 3-46B and 3-47B are listed the families found in four of the six years these stands were sampled by Texas Instruments. In Tables 3-48B and 3-49B are listed the forms in our single collection which were taken in abundance--defined for this purpose as those in which the relative number values add up to at least 3.

The total number of families in the Texas Instruments' collections, 127 in the young community and 126 in the old community, is less than in the stable foredune community where 157 were taken. The number of families represented in our collections on one date in 1980 is 59 for the open-canopied stand south of U.S. 12 and 45 for the mesophytic pocket. If we take into account that the number of famlilies taken in collections on a single date in a single year is likely to be doubled by collections over the course of several following years, as described above on page 3-134, the number we took in the open-canopied stand appears to be in line with the Texas Instruments' data. And the fact that only 45 families were taken from the mesophytic pocket does not appear so badly out of line when we note that only 41 families were taken in the young black oak community by Texas Instruments in 1977 and only 38 families were taken that same year from the stable foredune community, that community of those considered in this study from which ultimately the greatest number of families has been taken.

In Tables 3-46C and 3-47C are shown the trophic levels of the invertebrates taken in four of six sample years by Texas Instruments and in Tables 3-48C and 3-49C are shown the trophic levels of the invertebrates we collected in abundance. As in the foredune communities the largest number of families are herbivorous. Notable among these are leafhoppers, spittlebugs, planthoppers, and several moth families. Long-legged flies and spiders are among the predators and springtails and midges are among the scavengers in all cases. The parasitic braconid and ichneumon wasps are present in all cases, though not in sufficient number in a few cases to be listed among the families taken in abundance.

Forests on Glenwood and Calumet shorelines -- The forests described above are developed on stabilized dunes of Tolleston or post-Tolleston age. But also represented in the national lakeshore are two older shorelines, the Glenwood and Calumet. On these older substrates are developed forest communities which differ in certain respects from those described above. One of the most conspicuous of these differences is in the size of the trees: mature trees of these communities are invariably larger in both height and diameter than trees of the same species on Tolleston and younger substrates. This is a reflection of the much more favorable nutrient and moisture situation in these older substrates.

Table 3-49B. Invertebrates taken in abundance from mesophytic pocket of black oak forest northwest of Long Lake.

COLLEMBOLA--springtails
- Isotomidae

HEMIPTERA
- Nabidae--damsel bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Acanaloniidae--planthoppers

COLEOPTERA
- Elateridae--click beetles
- Helodidae--marsh beetles

LEPIDOPTERA
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Psychodidae--moth flies
- Chaoboridae--phantom midges
- Chironomidae--midges
- Culicidae--mosquitoes
- Cecidomyiidae--gall gnats
- Phoridae--humpbacked flies
- Dolichopodidae--long-legged flies
- Lauxaniidae--lauxaniids
- Muscidae--muscid flies

HYMENOPTERA
- Formicidae--ants

PSEUDOSCORPIONIDA--pseudoscorpions

ACARINA--mites

ARANEIDA--spiders

Table 3-49C. Trophic levels of invertebrates collected in abundance from mesophytic pocket of black oak forest northwest of Long Lake.

HERBIVORES
- Cicadellidae--leafhoppers
- Acanaloniidae--planthoppers
- Elateridae--click beetles
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths
- Cecidomyiidae--gall gnats

PREDATORS
- Nabidae--damsel bugs
- Chaoboridae--phantom midges
- Dolichopodidae--long-legged flies
- Pseudoscorpionida--pseudoscorpions
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Chironomidae--midges
- Phoridae--humpbacked flies

The Calumet dune complex lies just south of U.S. 12 and runs parallel to it from the western to the eastern border of the Tremont Unit. The vegetation of a forest stand on a ridge of Calumet age which lies about 2000 feet west of the national lakeshore visitor center is ranked in Table 3-50. The stand is coded F-2 on the land use map, for though the canopy is relatively closed where trees are present, there are a number of clearings in this stand, particularly on the south-facing slope. Species found primarily in these open areas are marked with an asterisk. This community, like most of those described above, is dominated by black oak. Lowbush blueberry is the most important shrub, and dryland blueberry and huckleberry are common associates. Virginia dwarf dandelion is important in the clearings in spring. Bracken fern is the most important herbaceous species in the summer. All these species have been listed in the black oak communities described above, with all except Virginia dwarf dandelion also having been ranked among the highest in their stratum in one or more stands. Among the low ranking associates several species are listed here for the fist time: pin cherry, blue toadflax, linear-leaved panic-grass, and pinesap; in fact, this is the only community in the national lakeshore in which we observed the last three.

The Glenwood dune complex lies just south of the Calumet complex; it also extends from the western to the eastern boundary of the Tremont Unit, in most cases just north of the national lakeshore's southern boundary. Several different stands on this complex were investigated. The first of these forests lies between Kemil Road and the eastern boundary of the Tremont Unit; its center is at the SE¼ NW¼ SW¼ of section 16, T 37 N, R 5 W. As the F-1 coding on the land use map indicates, the tree canopy of this community, as is true of all the forest communities on the Glenwood complex, is closed. The vegetation of this community is ranked in Table 3-51. As in most of the communities considered above, black oak is the dominant tree species; nine additional species are present, some of which--red maple and blackgum -- are known to require rather moist substrates. The most important plants of the shrub stratum are Virginia creeper and spicebush; false Solomon's-seal and bracken fern are important plants in the herb stratum. Spicebush, though possibly present in communities on younger substrates, is as we shall see a regularly important shrub in communities on older, mesic substrates. There appear also on this list for the first time (except in the case of special conditions: mesophytic pockets, lowland adjacent to Grand Marsh) several herbaceous species common in mesic communities: hairy sweet cicely, black snakeroot, enchanter's nightshade, rattlesnake fern, prairie trillium, and jack-in-the-pulpit.

The next stand on the Glenwood ridge, coded F-1 on the land use map, is just west of Kemil Road at NE¼ SE¼ SE¼, section 17, T 37 N, R 5 W. Its vegetation is ranked in Table 3-52. Black oaks is again the dominant tree species, though white oak and red oak are also quite important. As in the previous community on the Glenwood ridge, Virginia creeper is the most important plant in the shrub stratum. Wild sarsaparilla is the most important herb; though present in many

Table 3-50. Stratum ranking of plant species of forest on Calumet beach ridge west of Kemil Road--SE¼ SW¼ NE¼, section 17, T 37 N, R 5 W.

Quercus velutina black oak	7	Trees	
Quercus alba white oak	4		
Acer rubrum red maple	3		
Amelanchier sp. serviceberry	3		
Prunus pensylvanica pin cherry	3		
Prunus serotina black cherry	3		
Sassafras albidum sassafras	2		
Vaccinium angustifolium laevifolium lowbush blueberry	7	Shrubs	
Gaylussacia baccata huckleberry	4		
Vaccinium vacillans dryland blueberry	4		
Gaultheria procumbens wintergreen	3		
Rubus sp. rasp- black- berry	3		
Vitis sp. wild grape	3		
Rosa blanda meadow rose	2		
Krigia virginica Virginia dwarf dandelion	6*	Herbs	30 May 74
Arabis lyrata rockcress	4*		
Lithospermum caroliniense hairy puccoon	4*		
Rumex acetosella sheep sorrel	4*		
Aralia nudicaulis wild sarsaparilla	3		
Fragaria virginiana strawberry	3		
Linaria canadensis blue toadflax	3*		
Lupinus perennis lupine	3*		
Polygonatum sp. Solomon's-seal	3		

*Found primarily in open areas

Table 3-50 continued

Potentilla sp. cinquefoil	3*	
Smilacina racemosa false Solomon's-seal	3	
Panicum linearifolium slender-leaved panic-grass	2*	
Viola pedata birdfoot violet	2	
Pteridium aquilinum latiusculum braken fern	6	12 Aug. 74
Carex pensylvanica Pennsylvania sedge	4	
Solidago sp. goldenrod	4	
Andropogon scoparius little bluestem	3*	
Anemone cylindrica candle anemone	3	
Antennaria sp. pussytoes	3*	
Aster macrophyllus large-leaved aster	3	
Liatris aspera rough blazing-star	3	
Rudbeckia hirta black-eyed Susan	3	
Tephrosia virginiana goat's-rue	3	
Asclepias tuberosa butterfly-weed	2	
Euphorbia corollata flowering spurge	2	
Helianthus divaricatus woodland sunflower	2	
Monotropa hypopithys pinesap	2	
Maianthemum canadense false lily-of-the-valley	1	

*Found primarily in open areas

Table 3-51. Stratum ranking of plant species of forest on Glenwood beach ridge east of Kemil Road--SE¼ NW¼ SW¼, section 16, T 37 N, R 5 W., Tremont Unit.

Quercus velutina black oak	7	Trees
Fraxinus americana white ash	4	
Prunus serotina black cherry	4	
Quercus alba white oak	4	
Sassafras albidum sassafras	4	
Liriodendron tulipifera tuliptree	4	
Acer rubrum red maple	3	
Nyssa sylvatica blackgum	3	
Pinus strobus white pine	3	
Tilia americana basswood	3	
Ostrya virginiana ironwood	2	
Carpinus caroliniana blue beech	2	
Parthenocissus quinquefolia Virginia creeper	6	Shrubs
Lindera benzoin spicebush	5	
Prunus virginiana choke cherry	4	
Rhus radicans poison-ivy	4	
Rubus sp. rasp- black- berry	4 4	
Vitis sp. wild grape	4	
Cornus florida flowering dogwood	3	
Hamamelis virginiana witch-hazel	3	
Diervilla lonicera bush honeysuckle	2	
Ribes sp. currant	1	
Smilacina racemosa false Solomon's-seal	5	Herbs 23 May 79
Fragaria virginiana strawberry	4	
Geranium maculatum wild geranium	4	

Table 3-51 continued

Osmorhiza claytoni hairy sweet cicely	4	
Podophyllum peltatum May-apple	4	
Botrychium virginianum rattlesnake fern	3	
Equisetum arvense field horsetail	3	
Galium circaezans wild licorice	3	
Potentilla simplex common cinquefoil	3	
Equisetum hyemale affine common scouring-rush	2	
Ranunculus abortivus small-flowered buttercup	2	
Senecio aureus golden ragwort	2	
Trillium recurvatum prairie trillium	2	
Arisaema triphyllum jack-in-the-pulpit	1	
Circaea quadrisulcata canadensis enchanter's nightshade	4	5 July 78
Galium aparine cleavers	4	
Geum virginianum rough avens	3	
Polygonatum sp. Solomon's-seal	3	
Sanicula marilandica black snakeroot	3	
Smilex lasioneura carrion-flower	3	
Botrychium dissectum grapefern	2	
Carex pensylvanica Pennsylvania sedge	2	
Athyrium filix-femina michauxii lady fern	2	
Asplenium platyneuron ebony spleenwort	1	
Pteridium aquilinum latiusculum bracken fern	6	22 Sept. 79
Solidago caesia blue-stemmed goldenrod	4	
Helianthus divaricatus woodland sunflower	3	
Corallorhiza sp. coralroot	1	

Table 3-52. Stratum ranks of vegetation of forest stand on Glenwood beach ridge just west of Kemil Road--NE¼ SE¼ SE¼, section 17, T 37 N, R 5 W., Tremont Unit.

Quercus velutina black oak	7	Trees
Quercus alba white oak	6	
Quercus rubra red oak	5	
Acer rubrum red maple	4	
Sassafras albidum sassafras	4	
Cornus florida flowering dogwood	3	
Liriodendron tulipifera tuliptree	3	
Prunus serotina black cherry	3 3	
Carpinus caroliniana blue beech	1	
Carya ovata shagbark hickory	1	
Juglans cinerea butternut	1	
Parthenocissus quinquefolia Virginia creeper	5	Shrubs
Vaccinium vacillans dryland blueberry	4	
Vitis sp. wild grape	4	
Hamamelis virginiana witch-hazel	3	
Ribes sp. currant	3	
Rubus sp. rasp- black- berry	3	
Viburnum acerifolium mapleleaf viburnum	3	
Diervilla lonicera bush honeysuckle	2	
Rhus radicans poison-ivy	2	
Rosa blanda meadow rose	2	
Aralia nudicaulis wild sarsaparilla	6	Herbs 12 Aug. 74
Pteridium aquilinum latiusculum bracken fern	4	
Aster macrophyllus large-leaved aster	3	
Carex pensylvanica Pennsylvania sedge	3	
Circae quadrisulcata canadensis enchanter's nightshade	3	
Desmodium sp. tick-trefoil	3	
Polygonatum sp. Solomon's-seal	3	
Polygonum virginianum jumpseed	3	
Sanicula marilandica black snakeroot	3	
Smilacina racemosa false Solomon's-seal	3	
Solidago sp. goldenrod	3	
Botrychium virginianum rattlesnake fern	2	
Galium concinnum pretty bedstraw	2	
Osmorhiza claytoni hairy sweet cicely	2	
Prenanthes sp. rattlesnake-root	2	

of the black oak dominated stands described above, this is the first stand in which it achieves an especially high ranking; in the more mesic communities which follow this high a ranking is not uncommon. Included among the shrubs and herbs are many of the mesic species listed for the previous community; additional mesic species present here are mapleleaf viburnum and jumpseed.

The final forest observed on the Glenwood dune complex, with a closed canopy and coded F-1 on the land use map, is just west of the beginning and end of the horse trail in the SE¼ NW¼ of section 20, T 37 N, R 5 W. As a matter of fact this forest needs to be treated as two stands. First of all there is an upland stand, that on the higher and well drained slopes; this comprises the major part of this forest tract. Its plants are ranked in Table 3-53. As in the last stand described, black oak is the dominant tree species and quite a large number (ten) of additional tree species are present. Dryland blueberry is the most important shrub and wild sarsaparilla is again the highest ranked herb in the summer; interestingly, the most conspicuous herb in the late spring is squaw-root, a plant which is parasitic on the roots of a number of tree species. Included among the herbs are many of the mesic species listed for the previous communities; additional mesic species are round-lobed hepatica and honewort. Secondly, there is a lowland stand along the southern and western margins of the upland where the substrate is quite wet in the spring of the year and always more moist than on the ridges. The vegetation of this stand is ranked in Table 3-54. What is immediately conspicuous is that black oak is not the highest ranking tree species; it ranks behind white oak. There are fourteen additional tree species in this stand, including the mesic sugar maple and species regularly found in swamp forests (swamp white oak, pin oak, red maple, blue beech, and black ash). Also present are mesic and wet substrate plants in the shrub stratum (spicebush, common elder, and running evonymus) and in the herb stratum (smooth white violet, marsh blue violet, royal fern, touch-me-not, wild iris, lizard's-tail, water-hemlock, false nettle, sensitive fern, water-plantain, white baneberry, cinnamon fern, and turtlehead in addition to many of the mesic species listed for the previous three upland stands).

Between the Glenwood and the Calumet dune complexes there is an area of considerable size, extending both to the east and west of Kemil Road, in which there is very little relief. The topographic map shows this to lie between 630 and 640 feet in elevation. The substrate consists of sandy lake beds and muck and peat. Since it is relatively flat and lies between two ridges, water accumulates in this area and the vegetation growing there is considerably different than that on the Glenwood and Calumet uplands just described. To the east of Kemil Road most of this area is coded F-1 (woodland--closed canopy) on the land use map; most of this area to the west of Kemil Road is coded E-3 (swamp). The E-3 coding would be appropriate for much of the area east of Kemil Road, but it is not possible to distinguish between upland

Table 3-53. Stratum ranking of plant species of upland forest on Glenwood beach ridge west of where horse trail begins and ends-- SE¼ NW¼, section 20, T 37 N, R 5 W., Tremont Unit.

Quercus velutina black oak	8	Trees
Quercus alba white oak	5	
Acer rubrum red maple	4	
Amelanchier sp. serviceberry	4	
Cornus florida flowering dogwood	3	
Fraxinus americana white ash	3	
Prunus serotina black cherry	3	
Sassafras albidum sassafras	3	
Carya ovata shagbark hickory	2	
Quercus rubra red oak	1	
Juniperus virginiana creba red cedar	1	
Vaccinium vacillans dryland blueberry	6	Shrubs
Prunus virginana choke cherry	4	
Ribes sp. currant	4	
Rubus sp. rasp- black- berry	4	
Smilax sp. greenbirer	4	
Diervilla lonicera bush honeysuckle	3	
Hamamelis virginiana witch-hazel	3	
Parthenocissus quinquefolia Virginia creeper	3	
Rosa blanda meadow rose	3	
Sambucus canadensis common elder	3	
Vitis sp. wild grape	3	
Lindera benzoin spicebush	2	
Lonicera sp. honeysuckle	2	
Rhus radicans poison-ivy	2	

Table 3-53 continued

Vaccinium angustifolium laevifolium lowbush blueberry	2	
Viburnum dentatum arrow-wood	2	
Carya cordiformis bitternut hickory	1	
Juglans cinerea butternut	1	
Viburnum prunifolium black-haw	1	
Geranium maculatum wild geranium	4	Herbs 29 Apr. 74
Carex pensylvanica Pennsylvania sedge	3	
Hepatica americana round-lobed hepatica	2	
Arabis lyrata rockcress	1	
Conopholis americana squaw-root	5	30 May 74
Smilacina racemosa false Solomon's-seal	4	
Galium aparine cleavers	3	
Osmorhiza claytoni hairy sweet cicely	3	
Aralia nudicaulis wild sarsaparilla	4	12 Aug. 74
Aster macrophyllus large-leaved aster	3	
Circaea quadrisulcata canadensis enchanter's nightshade	3	
Cryptotaenia canadensis honewort	3	
Geum virginianum rough avens	3	
Sanicula marilandica black snakeroot	3	
Polygonatum sp. Solomon's-seal	2	
Aster sagittifolius arrow-leaved aster	3	20 Sept. 74
Aster azureus azure aster	3	
Aster dumosus bushy aster	3	
Aster macrophyllus large-leaved aster	3	
Desmodium glutinosum pointed-leaved tick-trefoil	3	
Desmodium illinoense Illinois tick-trefoil	3	
Gaultheria procumbens wintergreen	3	
Solidago nemoralis gray goldenrod	3	
Solidago ulmifolia elm-leaved goldenrod	3	
Corallorhiza maculata spotted coralroot	3	
Monotropa uniflora Indian pipe	2	
Prenanthes altissima tall white lettuce	2	

Table 3-54. Stratum ranking of plant species of forest in lowland along Glenwood beach ridge west of where horse trail begins and ends--SE¼ NW¼, section 20, T 37 N, R 5 W., Tremont Unit.

Quercus alba white oak	6	Trees
Quercus velutina black oak	5	
Quercus rubra red oak	4	
Acer rubrum red maple	3	
Fraxinus americana white ash	3	
Quercus bicolor swamp white oak	3	
Quercus palustris pin oak	3	
Tilia americana basswood	3	
Amelanchier sp. serviceberry	2	
Carpinus caroliniana blue beech	2	
Carya ovata shagbark hickory	2	
Liriodendron tulipifera tuliptree	2	
Ostrya virginiana ironwood	2	
Prunus serotina black cherry	2	
Acer saccharum sugar maple	1	
Fraxinus nigra black ash	1	
Lindera benzoin spicebush	4	Shrubs
Parthenocissus quinquefolia Virginia creeper	4	
Rhus radicans poison-ivy	4	
Viburnum acerifolium mapleleaf viburnum	4	
Crataegus sp. hawthorn	3	
Gaultheria procumbens wintergreen	3	
Prunus virginiana choke cherry	3	
Ribes sp. currant	3	
Sambucus canadensis common elder	3	

Table 3-54 continued

Euonymus obovatus running evonymus	2	
Hamamelis virginiana witch-hazel	2	
Vaccinium vacillans dryland blueberry	2	
Viburnum dentatum arrow-wood	2	
Viburnum prunifolium black-haw	2	
Berberis thunbergii Japanese barberry	1	
Carya cordiformis bitternut hickory	1	
Lonicera sp. honeysuckle	1	
Xanthoxylum americanum prickly ash	1	
Viola cucullata marsh blue violet	2	Herbs 29 Apr. 74
Viola pallens smooth white violet	2	
Osmunda regalis spectabilis royal fern	3	30 May 74
Viola striata cream violet	2	
Polygonum virginianum jumpseed	5	12 Aug. 74
Aster macrophyllus large-leaved aster	4	
Impatiens biflora touch-me-not	4	
Aralia racemosa spikenard	3	
Carex pensylvanica Pennsylvania sedge	3	
Circaea quadrisulcata canadensis enchanter's nightshade	3	
Conopholis americana squaw-root	3	
Cryptotaenia canadensis honewort	3	
Geum virginianum rough avens	3	
Polystichum acrostichoides Christmas fern	3	
Athyrium filix-femina michauxii lady fern	2	

Table 3-54 continued

Boehmeria cylindrica false nettle	2	
Cicuta maculata water-hemlock	2	
Desmodium nudiflorum naked-flowered tick-trefoil	2	
Desmodium sessilifolium sessile-leaved tick-trefoil	2	
Galium concinnum pretty bedstraw	2	
Iris virginica shrevei wild iris	2	
Lespedeza virginica slender bush-clover	2	
Onoclea sensibilis sensitive fern	2	
Sanicula marilandica black snakeroot	2	
Saururus cernuus lizard's-tail	2	
Actaea pachypoda white baneberry	1	
Alisma triviale common water-plantain	1	
Corallorhiza maculata spotted coralroot	1	
Hystrix patula bottle-brush grass	1	
Lycopus rubellus reddish bugle-weed	1	
Muhlenbergia sp. muhly	1	
Osmunda cinnamomea cinnamon fern	1	
Prunella vulgaris self-heal	1	
Solidago caesia blue-stemmed goldenrod	4	20 Sept. 74
Carex platyphylla broad-leaved sedge	3	
Aster sagittifolius arrow-leaved aster	2	
Aster azureus azure aster	2	
Aster lateriflorus woodland white aster	2	
Panicum sp. panic-grass	2	
Chelone glabra turtlehead	1	
Thelypteris hexagonoptera broad beechfern	1	

forest and lowland forest on the aerial photographs. And on examining the situation in the field it is seen that, in addition to some rather large expanses of swamp forest, there are scattered through the Glenwood complex whose vegetation is ranked in Table 3-51 numerous depressions in which swamp forest is present. This complexity can hardly be mapped. Description is more appropriate and this is done here in the context of the Glenwood and Calumet complexes rather than in the wetland section below.

The vegetation in this area between the Glenwood and Calumet ridges east of Kemil Road is more readily accessible for study than that to the west because much of it is in small patches around which one can walk. This vegetation is ranked in Table 3-55. The dominant tree is red maple; present also are many other wet substrate trees, such as willow, blackgum, pin oak, yellow birch, blue beech, and cottonwood. As in the Glenwood uplands, Virginia creeper and spicebush are important shrubs; in this lowland area they are joined by dewberry. Important plants in the herb stratum are wood anemone, false nettle, skunk cabbage, and royal, sensitive, cinnamon, and marsh ferns; the last five of these are restricted to wet substrates. Other plants limited to wet substrates are Pennsylvania and bulb bittercress, marsh marigold, Pennsylvania saxifrage, water parsnip, the several species of Bidens, and peat-moss. A marshy pocket in this lowland area, coded E-2 on the land use map, was also examined. At its center it consists, as far as can be determined while standing in the dense thicket of shrubs at its margin, of a pure stand of common cattail (SR 9). The dense thicket of shrubs consists of buttonbush (Cephalanthus occidentalis), SR 8, and marsh rose (Rosa palustris), SR 6. Trees immediately adjoining the marsh are blackgum (Nyssa sylvatica), SR 7; red maple (Acer rubrum), SR 6; willow (Salix sp.), SR 5.

The vegetation in the area between the Glenwood and Calumet ridges west of Kemil Road is difficult to assess because it is virtually impossible to walk through the area. There is much standing water in the portions coded E-3 (swamp), and there are dense tangles or rose and other shurbs in the more open areas coded F-3 (woodland--shrubs and trees). Therefore, no attempt was made to rank the vegetation here. Along the margin and in scattered clumps are willow, red maple, blackgum, pin oak, quaking aspen, cottonwood, white ash, and an occasional American elm, paper birch, and tuliptree. Forming a dense cover are the shrubs, primarily buttonbush, meadow-sweet, and hardhack, with Kalm's St.-John's-wort and swamp rose also being present. Large patches of common cattail and cinnamon, marsh, and royal fern are found in the herb stratum; dewberry (Rubus hispidus) and hair-cap moss (Polytrichum sp.) are less common in the herb stratum.

Table 3-55. Stratum ranks of vegetation of swamp forest patches between Glenwood and Calumet beach ridges east of Kemil Road--SE¼ SW¼ NW¼, section 16, T 37 N, R 5 W., Tremont Unit.

Acer rubrum red maple	7	Trees
Liriodendron tulipifera tuliptree	4	
Prunus serotina black cherry	4	
Fraxinus americana white ash	3	
Nyssa sylvatica blackgum	3	
Quercus palustris pin oak	3	
Salix sp. willow	3	
Betula lutea yellow birch	2	
Carpinus caroliniana blue beech	2	
Populus deltoids cottonwood	2	
Ulmus americana American elm	2	
Lindera benzoin spicebush	5	Shrubs
Parthenocissus quinquefolia Virginia creeper	5	
Rubus hispidus dewberry	5	
Prunus virginiana choke cherry	4	
Aronia melanocarpa black chokeberry	3	
Cornus sp. dogwood	3	
Sambucus canadensis common elder	3	
Sassafras albidum sassafras	2	
Anemone quinquefolia wood anemone	5	Herbs 22 May 79
Carex seorsa separated sedge	4	
Equisetum arvense field horsetail	4	
Platanus occidentalis sycamore	3	

Table 3-55 continued

Maianthemum canadense false lily-of-the-valley	3	
Podophyllum peltatum May-apple	3	
Ranunculus abortivus small-flowered buttercup	3	
Ranunculus recurvatus hooked buttercup	3	
Viola cucullata marsh blue violet	3	
Botrychium virginianum rattlesnake fern	2	
Caltha palustris marsh marigold	2	
Cardamine pensylvanica Pennsylvania bittercress	2	
Galium sp. bedstraw	2	
Galium aparine cleavers	2	
Polygonatum sp. Solomon's-seal	2	
Saxifraga pensylvanica Pennsylvania saxifrage	2	
Smilacina stellata starry false Solomon's-seal	2	
Arisaema triphyllum jack-in-the-pulpit	1	
Osmunda regalis spectabilis royal fern	6	5 July 78
Symplocarpus foetidus skunk-cabbage	6	
Osmunda cinnamomea cinnamon fern	5	
Onoclea sensibilis sensitive fern	5	
Thelypteris palustris pubescens marsh fern	5	
Smilacina racemosa false Solomon's-seal	5	
Impatiens biflora touch-me-not	4	
Sphagnum sp. peat-moss	3	
Boehmeria cylindrica false nettle	6	22 Sept. 79
Scirpus cyperinus wool-grass	2	
Solidago caesia blue-stemmed goldenrod	2	
Bidens aristosa bristled tickseed-sunflower	1	
Bidens coronata crowned tickseed-sunflower	1	
Bidens tripartita trifid beggar-ticks	1	
Eupatorium perfoliatum common boneset	1	
Sium suave water-parsnip	1	
Solidago patula rough-leaved goldenrod	1	

In Tables 3-56A and 3-57A are listed the invertebrates we collected on one date in the summer of 1980 from the Calumet and Glenwood beach ridges. In the collection from the Calumet ridge 45 families were taken; 50 were taken from the Glenwood ridge. Several additional years of collection can be expected, on the basis of the analysis previously described, to bring this number to well over a hundred.

In Tables 3-56B, 3-56C, 3-57B, and 3-57C are listed the invertebrates found in abundance, and the trophic levels they represent, in the collections from these two beach ridges. In these older and more mature forests, as in the younger forests described above, leafhoppers and moths are among the abundant herbivores and spiders among the abundant predators. Few other families of herbivores and predators, however were taken in abundance from these two forests, whereas a considerable number were taken in abundance from the younger black oak forests. Millipeds are present as abundant scavengers in these two stands in addition to the springtails which have been regularly present in this category. And ichneumon wasps continue to be abundant parasites.

Forests on other than sandy substrates -- All the forests considered above are developed on sandy substrates deposited by the action of wind and/or wave along the southern shore of present Lake Michigan or its ancestors. We have seen that forest communities on such substrates, no matter how long they have been there and how long the processes of succession have been in action, are dominated by black oak except under special circumstances. Several communities illustrating these circumstances have been described. Communities whose vegetation is ranked in Tables 3-35 and 3-39 contain depressions in which there is accumulation of litter and consequently a more moist substrate than usual in sand. Communities whose vegetation is ranked in Tables 3-42, 3-43, and 3-55 are developed in low lying areas which lie near the water table or where water accumulates.

But within the national lakeshore there are substrates other than sandy ones, and on them different types of forests develop. As in the case of the forests on the Glenwood dune complex all these forests have a closed canopy and the trees present regularly reach the size considered maximum for their species. These other substrates are the Valparaiso and Lake Border moraines and, lying between them, the lacustrine deposits of the Chesterton Embayment.

A forest stand, coded F-1 on the land use map, is developed on the Lake Border moraine in the Bailly Unit at the center of the west half of SE¼ NE¼, section 27, T 37 N, R 6 W. This is just west of the former Nike base, now the headquarters area of the national lakeshore. The vegetation of this stand is ranked in Table 3-58. This is clearly an oak-hickory type forest; the most important trees are white oak, red oak, and shagbark hickory. Many other species are present, among them a single mature beech, a species which shares

Table 3-56A. Invertebrates taken in samples collected July 22, 1980, from forest on Calumet beach ridge west of Kemil Road--SE¼ NW¼ SW¼, section 16, T 37 N, R 5 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
DIPLURA			
Campodeidae			2
COLLEMBOLA			
Isotomidae			2
Entomobryidae			2
ORTHOPTERA			
Acrididae	1		
Phasmatidae			
Diapheromera femorata	1		
Blattidae			
Parcoblatta sp.		1	
THYSANOPTERA			
Phloeothripidae			4
HEMIPTERA			
Miridae	1		
HOMOPTERA			
Cicadellidae	3		
Empoasca sp.		1	
Cercopidae	1		
COLEOPTERA			
Ptiliidae			2
Staphylinidae			1
Cantharidae			
Podabrus rugosulus	2		
Cleridae			
Phyllobaenus pallipennis	1		
Elateridae			1
Cryptophagidae			2
Anthicidae			
Anthicus sp.	1		
Pedilidae			
Macratria sp.	2		
Alleculidae			1
LEPIDOPTERA			
Noctuidae	1	2	
Geometridae	1		
Pyralidae			
Herculia himonialis		2	
Micromoths		1	1
DIPTERA			
Tipulidae	2	2	
Chironomidae		3	
Bibionidae	1		
Culicidae	2	4	

Table 3-56A continued

	netting/ sweeping	light traps	from litter
DIPTERA-Cont.			
Mycetophilidae	1		
Sciaridae		1	
Cecidomyiidae		1	
Phoridae	1	1	
Empididae		1	
Dolichopodidae			
Dolichopus sp.		3	
Sciaphus sp.	1		
Lauxaniidae		1	
Muscidae		1	
HYMENOPTERA			
Braconidae	1		
Ichneumonidae	1	2	
Eulophidae	1		
Tiphiidae	1		
Formicidae	3		2
PHALANGIDA	2	2	
PSEUDOSCORPIONIDA			2
ACARINA			4
ARANEIDA	3	1	3
DIPLOPODA			3

Table 3-56B. Invertebrates taken in abundance from forest on Calumet beach ridge west of Kemil Road.

THYSANOPTERA
Phloeothripidae--thrips
HOMOPTERA
Cicadellidae--leafhoppers
LEPIDOPTERA
Noctuidae--miller moths
DIPTERA
Tipulidae--crane flies
Chironomidae--midges
Culicidae--mosquitoes
Dolichopodidae--long-legged flies
HYMENOPTERA
Ichneumonidae--ichneumon wasps
Formicidae--ants
PHALANGIDA--daddy-long-legs
ACARINA--mites
ARANEIDA--spiders
DIPLOPODA--millipeds

Table 3-56C. Trophic levels of invertebrates collected in abundance from forest on Calumet beach ridge west of Kemil Road.

HERBIVORES
Cicadellidae--leafhoppers
Noctuidae--miller moths

PREDATORS
Dolichopodidae--long-legged flies
Araneida--spiders

SCAVENGERS
Chironomidae--midges
Diplopoda--millipeds

PARASITES
Ichneumonidae--ichneumon wasps

Table 3-57A. Invertebrates taken in samples collected July 22, 1980, from forest on Glenwood beach ridge west of where horse trail begins and ends--SE¼ NW¼, section 20, T 37 N, R 5 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
DIPLURA			
Campodeidae			2
COLLEMBOLA			
Poduridae			1
Isotomidae			3
Entomobryidae			3
Sminthuridae			1
ODONATA			
Aeschnidae	1		
ORTHOPTERA			
Acrididae			1
PSOCOPTERA			
Pseudocaeciliidae			2
THYSANOPTERA			
Phloeothripidae			3
HEMIPTERA			
Nabidae			
Nabis annulatus	3		
Tingidae			
Leptoypha sp.	1		
HOMOPTERA			
Cicadellidae	2		
Dikraneura sp.		2	
Cercopidae	2		
Aphididae	1		
COLEOPTERA			
Ptiliidae			2
Cantharidae			
Cantharis sp.			1
Podabrus rugosulus	1		
Lampyridae			
Photinus sp.			2
Elateridae			1
Athous sp.		1	
Helodidae			
Ptilodactyla serricollis		2	
Phalacridae			
Olibrus sp.			1
Mordellidae			
Anaspis sp.	1		

Table 3-57A continued

	netting/ sweeping	light traps	from litter
NEUROPTERA			
Corydalidae	1		
LEPIDOPTERA			
Noctuidae			
Apatela sp.	1	3	
Calpe canadensis		1	
Cosmia paleacea		2	
Geometridae			
Dyspteris abortivaria		2	
Pyralidae		2	
Pantographa limata		2	
Micromoths	1	3	
DIPTERA			
Tipulidae		2	
Chironomidae	2	3	
Culicidae	2	4	
Mycetophilidae		2	
Cecidomyiidae	1	1	
Threvidae			2
Asilidae			
Leptogaster annulatus		2	
Phoridae		2	
Dolichopodidae	1		
Dolichopus sp.		1	
Otitidae	1		
Lauxaniidae	1	2	
Chloropidae	1		
Diplotoxa sp.		1	
Calliphoridae	1		
Muscidae		1	
HYMENOPTERA			
Tenthredinidae	1		
Braconidae	3		
Ichneumonidae	1	2	
Eulophidae		1	
Formicidae	2		3
PHALANGIDA	1		
PSEUDOSCORPIONIDA			2
ACARINA			4
ARANEIDA	2		2
DIPLOPODA			3

Table 3-57B. Invertebrates taken in abundance from forest on Glenwood beach ridge west of where horse trail begins and ends.

COLLEMBOLA--springtails
- Isotomidae
- Entomobryidae

THYSANOPTERA
- Phloeothripidae--thrips

HEMIPTERA
- Nabidae--damsel bugs

HOMOPTERA
- Cicadellidae--leafhoppers

LEPIDOPTERA
- Noctuidae--miller moths
- Pyralidae--snout/grass moths
- Micromoths

DIPTERA
- Chironomidae--midges
- Culicidae--mosquitoes
- Lauxaniidae--lauxaniids

HYMENOPTERA
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps
- Formicidae--ants

ACARINA--mites

ARANEIDA--spiders

DIPLOPODA--millipeds

Table 3-57C. Trophic levels of invertebrates collected in abundance from forest on Glenwood beach ridge west of where horse trail begins and ends.

HERBIVORES
- Cicadellidae--leafhoppers
- Noctuidae--miller moths
- Pyralidae--snout/grass moths
- Micromoths

PREDATORS
- Nabidae--damsel bugs
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Entomobryidae--springtails
- Chironomidae--midges
- Diplopoda--millipeds

PARASITES
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps

Table 3-58. Stratum ranks of vegetation of forest stand on Lake Border moraine just west of Lakeshore headquarters--center of W½ SE¼ NW¼, section 27, T 37 N, R 6 W., Bailly Unit.

Quercus alba white oak	7	Trees
Quercus rubra red oak	6	
Carya ovata shagbark hickory	5	
Acer rubrum red maple	4	
Fraxinus americana white ash	3	
Prunus serotina black cherry	3	
Quercus velutina black oak	3	
Sassafras albidum sassafras	2	
Amelanchier sp. serviceberry	1	
Fagus grandifolia beech	1	
Juniperus virginiana creba red cedar	1	
Pinus banksiana jack pine	1	
Quercus bicolor swamp white oak	1	
Quercus palustris pin oak	1	
Robinia pseudo-acacia black locust	1	
Tilia americana basswood	1	
Parthenocissus quinquefolia Virginia creeper	7	Shrubs
Prunus virginiana choke cherry	7	
Ribes sp. currant	5	
Rhus radicans poison-ivy	4	
Crataegus sp. hawthorn	4	
Vitis sp. wild grape	4	
Diervilla lonicera bush honeysuckle	3	
Hamamelis virginiana witch-hazel	3	
Lindera benzoin spicebush	3	

Table 3-58 continued

Acer saccharum sugar maple	2	
Rubus sp. rasp- black- berry	2	
Sambucus canadensis common elder	2	
Berberis thunbergii Japanese barberry	1	
Anemonella thalictroides rue anemone	5	Herbs 1 May 74
Viola nephrophylla northern bog violet	4	
Geranium maculatum wild geranium	3	
Trillium recurvatum prairie trillium	3	
Hepatica americana round-lobed hepatica	2	
Ranunculus abortivus small-flowered buttercup	2	
Ranunculus septentrionalis swamp buttercup	2	
Viola conspersa dog violet	1	
Viola pubescens pubescens downy yellow violet	1	
Viola striata cream violet	1	
Claytonia virginica spring-beauty	6	21 May 74
Smilacina racemosa false Solomon's-seal	5	
Viola soraria woolly blue violet	5	
Arisaema triphyllum jack-in-the-pulpit	3	
Botrychium virginianum rattlesnake fern	3	

Table 3-58 continued

Galium aparine cleavers	3	
Osmorhiza claytoni hairy sweet cicely	3	
Polygonatum sp. Solomon's-seal	3	
Potentilla sp. cinquefoil	3	
Sanicula marilandica black snakeroot	3	
Uvularia grandiflora bellwort	2	
Circaea quadrisulcata canadensis enchanter's nightshade	7	12 Aug. 74
Polygonum virginianum jumpseed	5	
Agrimonia pubescens hairy agrimony	3	
Cryptotaenia canadensis honewort	3	
Galium concinnum pretty bedstraw	3	
Achillea millefolium yarrow	2	
Aralia nudicaulis wild sarsaparilla	2	
Prenanthes sp. rattlesnake-root	2	
Phryma leptostachya lopseed	1	
Prenanthes altissima tall white lettuce	3	4 Oct. 74
Solidago caesia blue-stemmed goldenrod	3	
Aster lateriflorus woodland white aster	2	
Aster sagittifolius arrow-leaved aster	2	
Fragaria virginiana strawberry	2	
Penthorum sedoides ditch stonecrop	1	

dominance with sugar maple in the beech-maple type forest; sugar maple saplings, but no mature trees, are present. Virginia creeper and choke cherry, both common in black oak dominated forests, are the most important shrubs; hawthorn is the only shrub on the list not common in black oak forests. Spring beauty is the most important herb in the spring; this species is not present in the black oak communities. Other herbs of importance, however--rue anemone, false Solomon's-seal, wooly blue violet, enchanter's nightshade, and jumpseed--are present and regularly common in the black oak communities.

During the Glenwood stage of Lake Chicago a long bay, the Chesterton Embayment, extended from west to east between the Lake Border and Valparaiso moraines. The east arm of the Little Calumet River flows from east to west through sediments deposited in this embayment. In the flood plain of the Little Calumet alluvial deposits are present. But the adjoining uplands consist primarily of lacustrine deposits which are silty clay in texture. Most of the forests growing on this upland have been partially cleared and used for residential purposes or completely cleared and used for agriculture. Two stands, however, remain within the bounds of the national lakeshore.

One of these stands is in the western portion of the Bailly Unit, about half a mile east of Indiana 149. It extends along the rim of the upland adjoining the Little Calumet River valley. The plants of this community are ranked in Table 3-59. This too is an oak-hickory type community. Shagbark hickory, black oak, and white oak share in dominance; only four additional tree species are found, each equal in importance. Poison ivy is the most important plant in the shrub stratum. The most important herb in the spring aspect is hairy sweet cicely; in the summer it is enchanter's nightshade. Both these species have been noted previously. A variety of goldenrods and asters are conspicuous in the fall, but no one species is particularly important. Prairie dock, a prairie indicator, is present with a stratum rank of 3, but no other prairie species is recognized.

The other stand developed on Chesterton Embayment deposits comprises the Blue Heron Rookery Unit. The eastern and western portions of this stand are sufficiently different to warrant separate treatment. Moreover, there are plants along the bank of the Little Calumet not found elsewhere in the stand that should be noted.

The vegetation of the eastern portion of this stand is ranked in Table 3-60. Beech and sugar maple share dominance. Eight additional tree species are present, but none of them is especially important. This is clearly a beech-maple community, the type of community considered climatic climax in this region, that is on mesic sites and under normal climatic conditions. The mesic conditions in which beech and maple thrive and which they perpetuate are apparently unsuitable for black oak, for this species which has been of such importance in most of the perviously described more xeric forest communities is for the first time not even present. Virginia creeper is the most important

Table 3-59. Stratum ranks of vegetation of forest on uplands adjoining Little Calumet River valley east of Ind. 149--at center of W margin of SW¼ SE¼, section 28, T 37 N, R 6 W., Bailly Unit.

Carya ovata shagbark hickory	6	Trees
Quercus velutina black oak	6	
Quercus alba white oak	6	
Prunus serotina black cherry	4	
Quercus palustris pin oak	4	
Quercus rubra red oak	4	
Tilia americana basswood	4	
Rhus radicans poison-ivy	6	Shrubs
Vitis sp. wild grape	4	
Aronia melanocarpa black chokeberry	3	
Crataegus sp. hawthorn	3	
Hamamelis virginiana witch-hazel	3	
Parthenocissus quinquefolia Virginia creeper	3	
Prunus virginiana choke cherry	3	
Rosa blanda meadow rose	3	
Berberis thunbergii Japanese barberry	2	
Osmorhiza claytoni hairy sweet cicely	5	Herbs 25 May 79
Podophyllum peltatum May-apple	4	
Apocynum androsaemifolium spreading dogbane	3	
Aralia nudicaulis wild sarsaparilla	3	
Claytonia virginica spring-beauty	3	
Galium aparine cleavers	3	
Geranium maculatum wild geranium	3	

Table 3-59 continued

Pteridium aquilinum latiusculum bracken fern	3	
Ranunculus septentrionalis swamp buttercup	3	
Silphium terebinthinaceum paririe-dock	3	
Viola sp. violet	3	
Galium boreale northern bedstraw	2	
Potentilla simplex common cinquefoil	2	
Ranunculus abortivus small-flowered buttercup	2	
Sanicula marilandica black snakeroot	2	
Anemonella thalictroides rue anemone	1	
Asarum canadense wild ginger	1	
Circaea quadrisulcata canadensis enchanter's nightshade	6	6 July 78
Arctium sp. burdock	3	
Fragaria virginiana strawberry	3	
Geum canadense white avens	3	
Impatiens biflora touch-me-not	3	
Smilacina racemosa false Solomon's-seal	3	
Actaea pachypoda white baneberry	2	
Agrimonia sp. agrimony	2	
Desmodium sp. tick-trefoil	2	
Onoclea sensibilis sensitive fern	2	
Smilax lasioneura carrion-flower	2	
Uvularia grandiflora bellwort	2	
Solidago caesia blue-stemmed goldenrod	5	21 Sept. 79
Aster lowrieanus Lowrie's aster	4	
Anemone cylindrica candle anemone	3	
Aster vimineus small white aster	3	
Helianthus divaricatus woodland sunflower	3	
Prenanthes alba white lettuce	3	
Silene stellata starry campion	3	
Solidago flexicaulis zigzag goldenrod	3	
Aster lateriflorus woodland white aster	2	
Aster sagittifolius arrow-leaved aster	2	

Table 3-60. Stratum ranks of vegetation of eastern portion of forest stand of Blue Heron Rookery Unit--N½ NW¼ SE¼, section 26, T 37 N, R 5 W.

Acer saccharum sugar maple	7	Trees
Fagus grandifolia beech	7	
Fraxinus americana white ash	4	
Quercus rubra red oak	4	
Acer rubrum red maple	3	
Prunus serotina black cherry	3	
Tilia americana basswood	3	
Ulmus americana American elm	3	
Carya ovata shagbark hickory	2	
Platanus occidentalis sycamore	1	
Parthenocissus quinquefolia Virginia creeper	5	Shrubs
Sassafras albidum sassafras	4	
Euonymus obovatus running evonymus	4	
Lindera benzoin spicebush	4	
Berberis thunbergii Japanese barberry	3	
Carpinus caroliniana blue beech	3	
Hamamelis virginiana witch-hazel	3	
Ostrya virginiana ironwood	3	
Smilax sp. greenbrier	3	
Viburnum acerifolium mapleleaf viburnum	3	
Viburnum dentatum arrow-wood	3	
Ribes sp. currant	2	
Rhus radicans poison-ivy	2	
Sambucus canadensis common elder	2	
Xanthoxylum americanum prickly ash	2	
Vitis sp. wild grape	2	

Table 3-60 continued

Sanicula marilandica black snakeroot	6	Herbs 30 May 79
Asarum canadense wild ginger	5	
Arisaema triphyllum jack-in-the-pulpit	4	
Podophyllum peltatum May-apple	4	
Osmorhiza longistylis smooth sweet cicely	4	
Smilacina racemosa false Solomon's-seal	4	
Caltha palustris marsh marigold	3	
Galium aparine cleavers	3	
Geranium maculatum wild geranium	3	
Hepatica acutiloba sharp-lobed hepatica	3	
Hydrophyllum virginianum Virginia waterleaf	3	
Ranunculus septentrionalis swamp buttercup	3	
Trillium recurvatum prairie trillium	3	
Viola rostrata long-spurred violet	3	
Allium canadense wild garlic	2	
Carex intumescens swollen sedge	2	
Cardamine bulbosa bulb bittercress	2	
Cicuta maculata water-hemlock	2	
Dryopteris spinulosa intermedia common woodfern	2	
Galium circaezans wild licorice	2	
Galium triflorum fragrant bedstraw	2	
Phlox divaricata blue phlox	2	
Iris virginica shrevei wild iris	2	
Onoclea sensibilis sensitive fern	2	

Table 3-60 continued

Symplocarpus foetidus skunk-cabbage	2	
Arisaema dracontium green dragon	1	
Boehmeria cylindrica false nettle	3	24 July 78
Equisetum laevigatum smooth scouring-rush	3	
Galium concinnum pretty bedstraw	3	
Dentaria laciniata toothwort	3	
Polygonatum sp. Solomon's-seal	3	
Allium tricoccum wild leek	3	
Thelypteris novaboracensis New York fern	3	
Sanguinaria canadensis bloodroot	3	
Impatiens biflora touch-me-not	3	
Mitchella repens partridge-berry	3	
Actaea pachypoda white baneberry	2	
Carex pensylvanica Pennsylvania sedge	2	
Hystrix patula bottle-brush grass	2	
Polystichum acrostichoides Christmas fern	2	
Cryptotaenia canadensis honewort	5	28 Sept. 79
Sanicula trifoliata large-fruited snakeroot	5	
Laportea canadensis wood-nettle	5	
Solidago caesia blue-stemmed goldenrod	5	
Aster vimineus small white aster	4	
Polygonum virginianum jumpseed	4	
Aster lowrieanus Lowrie's aster	3	
Botrychium virginianum rattlesnake fern	3	
Cinna arundinacea woodreed	3	
Oxypolis rigidior cowbane	3	
Pilea pumila clearweed	3	
Prenanthes alba white lettuce	3	
Solidago flexicaulis zigzag goldenrod	3	
Chelone glabra turtlehead	2	
Eupatorium rugosum white snakeroot	2	
Botrychium dissectum grapefern	1	

plant of the shrub stratum; next in ranking are running evoynmus and spicebush, which were noted above as species requiring mesic conditions, and pawpaw which has not been listed previously. In spring the most important herbs are black snakeroot and wild ginger; in the fall it is honewort, blue-stemmed goldenrod, wood-nettle, and large-fruited snakeroot. All but the last two listed have regularly been of some importance in communities beginning with those on Glenwood deposits. Present are a number of species thriving on wet substrates, thus indicating that condition in certain parts and/or at certain times of the year; among these are marsh marigold, swamp buttercup, bulb bittercress, water hemlock, wild iris, sensitive fern, and skunk-cabbage. One need not observe these last listed plants, however, to appreciate that conditions are wet in this stand. A person entering the community from the adjacent fields is during most of the year immediately greeted by a hungry swarm of mosquitoes. It should be noted that this is the portion of the Blue Heron Rookery Unit where the rookery is located.

The vegetation of the western portion of the forest of the Blue Heron Rookery Unit is ranked in Table 3-61. Sugar maple and beech are among the highest ranked trees in this community, but they share dominance with eight other species: red maple, white ash, cottonwood, bigtooth aspen, sycamore, basswood, American elm, and shagbark hickory. That most of these are species which do well in wet substrates (shagbark hickory is an exception) suggests that this portion of the stand is wetter than the eastern portion. This is confirmed by the presence, though that would hardly seem possible, of even more mosquitoes than in the eastern portion. This abundance of mosquitos plus the widespread and abundant wood-nettle in the herb stratum in the summer and fall make this the least pleasant, in terms of comfort, of all the communities in the national lakeshore; the eastern portion is, for the same reasons, a close second in this respect. Spicebush, Virginia creeper, and wild grape are the most important species in the shrub stratum; they and the less important shrub species are much like those in the eastern portion. Smooth sweet cicely, cleavers, swamp buttercup, cream violet, black snakeroot, wood-nettle, and honewort are the most important herbaceous species; the last three listed have ranked as highly in previously described communities, but this is the first community in which the first four (though previously listed) have been ranked so highly. The same wet substrate herbs listed for the eastern portion are also present here.

The channel of the Little Calumet which extends through the Blue Heron Rookery Unit has been dredged and straightened, and spoils banks are obvious alongside many sections of the channel. Growing on these banks and elsewhere immediately adjacent to the channel is vegetation which is different in certain respects from that described above. That vegetation is ranked in Table 3-62. The trees which share dominance in forming the gallery forest along the channel are all species adapted to wet substrates: red maple, white ash, sycamore, cottonwood, willow, and American elm. Virginia creeper, rasp-black- berry, and wild grape are the most important plants of the shrub stratum. Most of the herbs

Table 3-61. Stratum ranks of vegetation of western portion of forecast stand of Blue Heron Rookery Unit--SE¼, section 27, T 37 N, R 5 W.

Acer rubrum red maple	5	Trees
Acer saccharum sugar maple	5	
Carya ovata shagbark hickory	5	
Fagus grandifolia beech	5	
Fraxinus americana white ash	5	
Populus deltoides cottonwood	5	
Populus grandidentata bigtooth aspen	5	
Platanus occidentalis sycamore	5	
Tilia americana basswood	5	
Ulmus americana American elm	5	
Carpinus caroliniana blue beech	4	
Liriodendron tulipifera tuliptree	4	
Ostrya virginiana ironwood	4	
Prunus serotina black chery	3	
Quercus rubra red oak	3	
Lindera benzoin spicebush	6	Shrubs
Parthenocissus quinquefolia Virginia creeper	5	
Vitis sp. wild grape	5	
Asimina triloba pawpaw	4	
Hamamelis virginiana witch-hazel	4	
Berberis thundergii Japanese barberry	3	
Crataegus sp. hawthorn	3	
Euonymus obovatus running evonymus	3	

Table 3-61 continued

Hepatica acutiloba sharp-lobed hepatica	3	
Heracleum maximum cow-parsnip	3	
Isopyrum biternatum false rue anemone	3	
Mitela diphylla bishop's-cap	3	
Podophyllum peltatum May-apple	3	
Senecio aureus golden ragwort	3	
Symplocarpus foetidus skunk-cabbage	3	
Trillium recurvatum prairie trillium	3	
Sanicula trifoliata large-fruited snakeroot	3	
Saxifraga pensylvanica Pennsylvania saxifrage	3	
Anemone quinquefolia wood anemone	2	
Anemonella thalictroides rue anemone	2	
Caltha palustris marsh marigold	2	
Galium triflorum fragrant bedstraw	2	
Cardamine bulbosa bulb bittercress	2	
Cicuta maculata water-hemlock	2	
Iris virginica shrevei wild iris	2	
Maianthemum canadense false lily-of-the-valley	2	
Mitchella repens partridge-berry	2	
Onoclea sensibilis sensitive fern	2	
Potentilla simplex common cinquefoil	2	
Trillium grandiflorum large-flowered trillium	2	
Laportea canadensis wood-nettle	6	24 July 78
Smilacina racemosa false Solomon's-seal	4	

Table 3-61 continued

Ribes sp. currant	3	
Rhus radicans poison-ivy	3	
Rosa blanda meadow rose	3	
Smilax sp. greenbrier	3	
Viburnum acerifolium mapleleaf viburnum	3	
Viburnum dentatum arrow-wood	3	
Xanthoxylum americanum prickly ash	3	
Sambucus canadensis common elder	2	
Osmorhiza longistylis smooth sweet cicely	7	Herbs 30 May 79
Galium aparine cleavers	5	
Ranunculus spetentrionalis swamp buttercup	5	
Sanicula marilandica black snakeroot	5	
Viola striata cream violet	5	
Chaerophyllum procumbens chervil	4	
Asarum canadense wild ginger	4	
Geranium maculatum wild geranium	4	
Hydrophyllum virginianum Virginia waterleaf	4	
Impatiens biflora touch-me-not	4	
Phlox divaricata blue phlox	4	
Allium tricoccum wild leek	3	
Allium canadense wild garlic	3	
Arisaema triphyllum jack-in-the-pulpit	3	
Thelypteris novaboracensis New York fern	3	

Table 3-61 continued

Boehmeria cylindrica false nettle	4	
Actaea pachypoda white baneberry	3	
Amphicarpa bracteata hog-peanut	3	
Botrychium virginianum rattlesnake fern	3	
Circaea quadrisulcata canadensis enchanter's nightshade	3	
Carex pensylvanica Pennsylvania sedge	3	
Geum canadense white avens	3	
Prenanthes sp. rattlesnake-root	3	
Polystichum acrostichoides Christmas fern	3	
Sanguinaria canadensis bloodroot	3	
Thelypteris palustris pubescens marsh fern	3	
Caulophyllum thalictroides blue cohosh	2	
Phryma leptostachya lopseed	2	
Cryptotaenia canadensis honewort	5	28 Sept. 79
Pilea pumila clearweed		
Polygonum virginianum jumpseed	4	
Sanicula trifoliata large-fruited snakeroot	4	
Aster vimineus small white aster	3	
Eupatorium rugosum white snakeroot	3	
Aster lowrieanus Lowrie's aster	2	
Chelone glabra turtlehead	2	
Urtica procera tall nettle	2	
Campanula americana tall bellflower	1	
Echinocystis lobata wild cucumber	1	

Table 3-62. Stratum ranks of woody plants of gallery forest along banks of Little Calumet River in Blue Heron Rockery Unit and of herbaceous plants found there but not in adjoining dense forest.

Acer rubrum red maple	5	Trees
Fraxinus americana white ash	5	
Platanus occidentalis sycamore	5	
Populus deltoides cottonwood	5	
Salix sp. willow	5	
Ulmus americana American elm	5	
Acer saccharinum silver maple	2	
Parthenocissus quinquefolia Virginia creeper	5	Shrubs
Rubus sp. rasp- black- berry	5	
Vitis sp. wild grape	5	
Asimina triloba pawpaw	4	
Sambucus canadensis common elder	3	
Xanthoxylum americanum prickly ash	2	
Ambrosia trifida great ragweed	3	Herbs
Cystopteris fragilis fragile fern	3	
Equisetum arvense field horsetail	3	
Equisetum hyemale affine common scouring-rush	3	
Helianthus annuus common sunflower	3	
Ranunculus abortivus small-flowered buttercup	3	
Rudbeckia laciniata green-headed coneflower	3	
Thalictrum dasycarpum purple meadow-rue	3	
Verbena urticifolia white vervain	2	

found in the adjoining stands are also present here, but no attempt was made to list and rank them. Ranked in the table are only those herbs found along the banks that are not found in the adjoining stands. No species is especially important. Most species are those adapted to open, sunny places, therefore, present here on the open banks but not in the heavily shaded forests.

Pinhook Bog occupies a depression in the glacial till of the Valparaiso moraine. Forests are developed on the uplands which drain into this basin. North of the bog, just east of Wozniak Road, is a forest coded F-1 and F-3 on the land use map. The land here slopes down rather sharply to the bog. The vegetation of the forest stand on this south-facing slope is ranked in Table 3-63. White oak, red oak, and shagbark hickory are the dominant tree species. The situation here is somewhat different from that in the communities described above as oak-hickory communities (see Tables 3-58 and 3-59). In those the oaks and hickories are accompanied by only a few other tree species (two in one case, four in the other). In this stand there are eleven such species. Among these species are beech with a stratum rank of 4 and sugar maple with a rank of 3, and the significance of these particular species has been referred to above. Thus this stand should probably be recognized as a mixed mesophytic community. Virginia creeper and chokecherry are the dominant plants of the shrub stratum. Rue anemone, spring beauty, false Solomon's-seal, wooly blue violet, enchanter's nightshade, and jumpseed--all of them previously noted--are the most important herbs.

South of the bog just east of Wozniak Road there is a relatively small (6.3 acres) forest stand coded F-1. Here again the land slopes sharply to the bog. The vegetation of the stand on this north-facing slope is ranked in Table 3-64. Though virtually the same tree species are present here as in the stand on the south-facing slope 2000 feet away, the ranking in this stand is considerably different. Sugar maple is clearly the dominant tree; ranking next in importance is beech. All the remaining are of lesser rank. On this slope, subjected to lesser drying than that facing south which receives the sun's rays more directly, soil conditions are sufficiently moist that maple and beech are the most important trees. A beech-maple community exists here. Spicebush is the most important shrub in this community. Forty species of herbaceous plants were recognized in this small stand, half of them in the spring. Toothwort is the most important spring species; wild sarsaparilla and early meadowrue are the most important summer species; asters and goldenrods are common in the fall.

Table 3-63. Stratum ranks of vegetation of forest stand north of Pinhook Bog--SE¼ NE¼ NW¼, section 35, T 37 N, R 4 W.

Quercus alba white oak	6	Trees
Carya ovata shagbark hickory	5	
Quercus rubra red oak	5	
Acer rubrum red maple	4	
Fagus grandifolia beech	4	
Acer saccharum sugar maple	3	
Prunus serotina black cherry	3	
Quercus velutina black oak	3	
Sassafras albidum sassafras	3	
Tilia americana basswood	3	
Carya ovalis red hickory	2	
Cornus florida flowering dogwood	2	
Liriodendron tulipifera tuliptree	2	
Ostrya virginiana ironwood	2	
Populus grandidentata bigtooth aspen	2	
Ulmus americana American elm	2	
Hamamelis virginiana witch-hazel	4	Shrubs
Lindera benzoin spicebush	4	
Parthenocissus quinquefolia Virginia creeper	4	
Viburnum acerifolium mapleleaf viburnum	4	
Vitis sp. wild grape	4	
Crataegus sp. hawthorn	3	
Rosa blanda meadow rose	3	
Smilax sp. greenbrier	3	

Table 3-63 continued

Ribes sp. currant	3	
Anemonella thalictroides rue anemone	5	Herbs 30 May 79
Arisaema triphyllum jack-in-the-pulpit	4	
Podophyllum peltatum May-apple	4	
Dentaria laciniata toothwort	3	
Geranium maculatum wild geranium	3	
Actaea pachypoda white baneberry	2	
Allium tricoccum wild leek	2	
Galium aparine cleavers	2	
Polygonatum sp. Solomon's-seal	2	
Ranunculus abortivus small-flowered buttercup	2	
Viola hirsutula southern wood violet	2	
Viola soraria woolly blue violet	2	
Viola sagittata arrow-leaved violet	1	
Osmorhiza claytoni hairy sweet cicely	5	24 July 78
Aquilegia canadensis columbine	4	
Smilacina racemosa false Solomon's-seal	4	
Antennaria neglecta field pussytoes	3	
Aureolaria flava yellow false foxglove	3	
Galium triflorum fragrant bedstraw	3	
Galium concinnum pretty bedstraw	3	
Hystrix patula bottle-brush grass	3	
Desmodium rotundifolium prostrate tick-trefoil	3	
Lycopodium complanatum ground-cedar	3	

Table 3-63 continued

Monotropa uniflora Indian pipe	3	
Prenanthes sp. rattlesnake-root	3	
Agrimonia gryposepala tall hairy agrimony	2	
Carex pensylvanica Pennsylvania sedge	2	
Circaea quadrisulcata canadensis enchanter's nightshade	2	
Polygonatum sp. Solomon's-seal	2	
Phryma leptostachya lopseed	1	
Solidago caesia blue-stemmed goldenrod	4	28 Sept. 79
Aster azureus azure aster	3	
Aster lowrieanus Lowrie's aster	3	
Eupatorium purpureum sweet Joe-Pye-weed	3	
Eupatorium rugosum white snakeroot	3	
Uvularia grandiflora bellwort	3	
Aster vimineus small white aster	2	
Epifagus virginiana beech-drops	2	
Polygonum virginianum jumpseed	2	
Prenanthes alba white lettuce	2	
Sanicula trifoliata large-fruited snakeroot	2	
Smilax lasioneura carrion-flower	2	
Corallorhiza sp. coralroot	1	

Table 3-64. Stratum ranks of vegetation of forest stand south of Pinhook Bog--NW¼ NE¼ SW¼, section 35, T 37 N, R 4 W.

Acer saccharum sugar maple	6	Trees
Fagus grandifolia beech	4	
Carpinus caroliniana blue beech	3	
Carya ovata shagbark hickory	3	
Carya ovalis red hickory	3	
Ostrya virginiana ironwood	3	
Quercus alba white oak	3	
Quercus rubra red oak	3	
Sassafras albidum sassafras	3	
Tilia americana basswood	3	
Acer rubrum red maple	2	
Prunus serotina black cherry	2	
Quercus velutina black oak	2	
Liriodendron tulipifera tuliptree	2	
Ulmus americana American elm	2	
Lindera benzoin spicebush	5	Shrubs
Hamamelis virginiana witch-hazel	4	
Parthenocissus quinquefolia Virginia creeper	4	
Viburnum acerifolium mapleleaf viburnum	4	
Vitis sp. wild grape	4	
Crataegus sp. hawthorn	3	
Rosa blanda meadow rose	3	
Smilax sp. greenbrier	3	

Table 3-64 continued

Euonymus obovatus running evonymus	3	
Celastrus scandens bittersweet	2	
Ribes sp. currant	2	
Amelanchier sp. serviceberry	1	
Dentaria laciniata toothwort	5	Herbs 20 May 79
Anemonella thalictroides rue anemone	4	
Actaea pachypoda white baneberry	4	
Allium tricoccum wild leek	4	
Hydrophyllum appendiculatum appendaged waterleaf	4	
Trillium grandiflorum large-flowered trillium	4	
Botrychium virginianum rattlesnake fern	3	
Claytonia virginica spring-beauty	3	
Dicentra canadensis squirrel-corn	3	
Erythronium sp. dog-tooth violet	3	
Geranium maculatum wild geranium	3	
Hydrophyllum appendiculatum appendaged waterleaf	3	
Phlox divaricata blue phlox	3	
Polystichum acrostichoides Christmas fern	3	
Sanguinaria canadensis bloodroot	3	
Viola pubescens eriocarpa smooth yellow violet	3	
Dryopteris spinulosa intermedia common woodfern	2	
Arisaema triphyllum jack-in-the-pulpit	2	
Anemone quinquefolia wood anemone	2	

Table 3-64 continued

Ranunculus recurvatus hooked buttercup	1	
Aralia nudicaulis wild sarsaparilla	5	29 July 78
Thalictrum dioicum early meadowrue	5	
Galium circaezans wild licorice	4	
Hepatica acutiloba sharp-lobed hepatica	4	
Podophyllum peltatum May-apple	4	
Carex pensylvanica Pennsylvania sedge	3	
Carex plantaginea plantain-leaved sedge	3	
Epifagus virginiana beech-drops	2	
Mitchella repens partridge-berry	2	
Sanicula trifoliata large-fruited snakeroot	2	
Monotropa uniflora Indian pipe	1	
Solidago caesia blue-stemmed goldenrod	4	28 Sept. 79
Solidago flexicaulis zigzag goldenrod	4	
Aster lowrieanus Lowrie's aster	3	
Carex plantaginea plantain-leaved sedge	3	
Prenanthes alba white lettuce	3	
Laportea canadensis wood-nettle	3	
Aster vimineus small white aster	2	
Aster macrophyllus large-leaved aster	2	
Eupatorium rugosum white snakeroot	2	
Thelypteris hexagonoptera broad beechfern	2	

In Tables 3-65A and 3-66A are listed the invertebrates collected from the oak-hickory forest on the Lake Border moraine and the beech-maple forest in the eastern portion of the Blue Heron Rookery Unit. The numbers of families collected from these two forests on a single date are 40 and 46 respectively. Forty is the lowest number of families represented in any of our collections from terrestrial communities, but it is not strikingly out of line with the 45 taken from the mesophytic pocket and the Calumet beach ridge or the 46 taken from the beech-maple forest; and, as noted previously, only 38 families were taken in 1977 by Texas Instruments from the stable foredune community, that community of those considered in this study from which ultimately the greatest number of families has been taken.

In Tables 3-65B, 3-65C, 3-66B, and 3-66C are listed the invertebrates found in abundance in these two forest communities and the trophic levels which they occupy. Leafhoppers, spittlebugs, and several moth families are again among the abundant herbivores; gall gnats are a new addition to this trophic level. Long-legged flies and spiders are again among the abundant predators, and ichneumon wasps among the abundant parasites. Springtails and midges are again among the abundant scavengers; a new addition to this trophic level are the humpbacked flies.

Hoosier Prairie -- The final terrestial community to be discussed is a relatively undisturbed patch of prairie known as Hoosier Prairie. Lying ten miles southwest of the southwest portion of the West Unit, it is formed on lacustrine sand and beach sands and gravel deposited during the Glenwood stage of glacial Lake Chicago. Being formed on sand the community types present here are considered sand prairies as distinct from black silt-loam prairies of moraines and till plains.

Several community types are represented in Hoosier Prairie. Landers (1975) refers to it as a mosaic of savannah, mesic prairie, low prairie, and prairie marsh. On the other hand, Bacone (1977, based on his experience with John White whose report was published in 1979) recognizes many more types: black oak forest, dry oak savannah, dry-mesic oak savannah, dry prairie, dry-mesic prairie, mesic prairie, wet-mesic prairie, wet prairie/sedge meadow, mesic prairie/shrub heath, aspen-willow thicket, shrub swamp, and marsh. The situation being dealt with is one in which there is variation primarily in the water availability in the substrate, but variation also with respect to burning. How many types one wishes to recognize in this continuum is a matter of one's preference as to fineness of distinction and of what purpose one has in making distinctions. Bacone's distinctions, for example, are valuable for indicating the great diversity of habitat types represented, but thwart attempts at mapping. Inasmuch as our descriptions are referenced to land use maps we have adopted categories which can be related to features that can be reconized on aerial photographs and mapped with assurance after field checking. The categories group those types which Bacone recognizes; in the descriptions reference will be made to significant variations within our broader categories.

Table 3-65A. Invertebrates taken in samples collected July 23, 1980, from forest stand on Lake Border moraine just west of Lakeshore headquarters--center of W½ SE¼ NE¼, section 27, T 37 N, R 6 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
COLLEMBOLA			
Isotomidae			3
Entomobryidae			2
HEMIPTERA			
Nabidae	3		
Tingidae	1		
Berytidae			
Jalysus sp.	1		
Pentatomidae	1		
HOMOPTERA			
Cicadellidae			
Erythroneura sp.	2		
Flexamia sp.	2	1	
Graphocephala sp.	1		
Cercopidae	3		
Flatidae	2		
Aphididae	1		
COLEOPTERA			
Elateridae			1
Coccinellidae			
Psyllobora viginitimaculata	1		
Cerambycidae			
Eupogonius vestitus	1		
Chrysomelidae			
Nodonota sp.	1		
Pachybrachys sp.	1		
NEUROPTERA			
Corydalidae		2	
MECOPTERA			
Bittacidae			
Bittacus sp.	1		
LEPIDOPTERA			
Arctiidae			
Halisodota tesselaris		1	
Noctuidae			
Apatela sp.		3	
Prothymia sp.		1	
Geometridae			
Abbotana clemitaria		1	
Pyralidae			
Herculia himonialis		1	
Pantographa limata		2	
Micromoths	1		

Table 3-65A continued

	netting/ sweeping	light traps	from litter
DIPTERA			
Tipulidae	2	2	
Chaoboridae		3	
Chironomidae	3	4	
Culicidae		2	
Sciaridae	1	1	
Cecidomyiidae		3	
Phoridae	2	2	
Dolichopodidae			
Condylostylus sp.	1		
Dolichopus sp.	3	2	
Hydrophorus sp.	1		
Psilopiella sp.	1		
Thinophilus sp.		4	
Chloropidae	2		
Calliphoridae	2		
HYMENOPTERA			
Braconidae	1		
Ichneumonidae	2	1	
Chrysididae	1		
Eupelmidae	1		
Formicidae	2		
PHALANGIDA	3	2	
ACARINA			3
ARANEIDA	2		2
CHILOPODA			2

Table 3-65b. Invertebrates taken in abundance from forest on Lake Border moraine just west of Lakeshore headquarters.

COLLEMBOLA--springtails
- Isotomidae

HEMIPTERA
- Nabidae--damsel bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs

LEPIDOPTERA
- Noctuidae--miller moths
- Pyralidae--snout/grass moths

DIPTERA
- Tipulidae--crane flies
- Chaoboridae--phantom midges
- Chironomidae--midges
- Cecidomyiidae--gall gnats
- Phoridae--hympbacked flies
- Dolichopodidae--long-legged flies

HYMENOPTERA
- Ichneumonidae--ichneumon wasps

PHALANGIDA--daddy-long-legs

ACARINA--mites

ARANEIDA--spiders

Table 3-65c. Trophic levels of invertebrates collected in abundance from forest on Lake Border moraine just west of Lakeshore headquarters.

HERBIVORES
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Noctuidae--miller moths
- Pyralidae--snout/grass moths
- Cecidomyiidae--gall gnats

PREDATORS
- Nabidae--damsel bugs
- Chaoboridae--phantom midges
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Chironomidae--midges
- Phoridae--humpbacked flies

PARASITES
- Ichneumonidae--ichneumon wasps

Table 3-66A. Invertebrates taken in samples collected July 29, 1980, from eastern portion of forest stand of Blue Heron Rookery Unit--N½ NW¼ SE¼, section 26, T 37 N, R 5 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
DIPLURA			
Campodeidae			2
COLLEMBOLA			
Isotomidae			3
HEMIPTERA			
Nabidae	2		
Pentatomidae	1		
HOMOPTERA			
Membracidae			
Ceresa sp.	1		
Cicadidae	1		
Cicadellidae			
Empoasca sp.		3	
Graphocephala sp.	1		
Gyponana sp.		1	
Scophoideus sp.	3		
Cercopidae	3		
Flatidae	2		
Acanaloniidae		1	
COLEOPTERA			
Staphylinidae			2
Cantharidae			
Cantharis rectus	1		
Lampyridae			
Photinus sp.	2		
Photuris pennsylvanica		2	
Elateridae			3
Agriotes oblongicollis	1		
Athous sp.		1	
Cryptophagidae			
Telephanus velox			1
Nitidulidae			
Epuraea sp.			2
Glischrochilus fasciatus			2
Mycetophagidae			
Mycetophagus sp.			1
Scarabaeidae			
Ataenius sp.			1
Chrysomelidae			
Phyllotreta bipustulata			1
Curculionidae			1
NEUROPTERA			
Chrysopidae		2	

Table 3-66A continued

	netting/ sweeping	light traps	from litter
MECOPTERA			
Bittacidae			
Bittacus sp.	1		
LEPIDOPTERA			
Noctuidae			
Apatela sp.	1	3	
Geometridae			
Chlorochlamys chlorleucaria		2	
Ectropis crepuscularia		2	
Micromoths	1	3	
DIPTERA			
Tipulidae		2	
Chironomidae		4	
Culicidae	3	4	
Sciaridae		1	
Cecidomyiidae	2	2	
Phoridae	2	2	
Empididae		1	
Dolichopodidae			
Dolichopus sp.	2		
Gymnoternus sp.		2	
Calliphoridae	2		
HYMENOPTERA			
Cephidae		1	
Braconidae	2		
Ichneumonidae	3		
Pteromalidae	1		
Formicidae	3	1	3
PHALANGIDA	3	3	
PSEUDOSCORPIONIDA			2
ACARINA			4
ARANEIDA	3		2
ISOPODA	1		2
DIPLOPODA			3
CHILOPODA			2

Table 3-66B. Invertebrates taken in abundance from eastern portion of forest stand of Blue Heron Rookery Unit.

COLLEMBOLA--springtails
- Isotomidae

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs

COLEOPTERA
- Lampyridae--fireflies
- Elateridae--click beetles
- Nitidulidae--sap beetles

LEPIDOPTERA
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths

DIPTERA
- Chironomidae--midges
- Culicidae--mosquitoes
- Cecidomyiidae--gall tnats
- Phoridae--humpbacked flies
- Dolichopodidae--long-legged flies

HYMENOPTERA
- Ichneumonidae--icnneumon wasps
- Formicidae--ants

PHALANGIDA--daddy-long-legs
ACARINA--mites
ARANEIDA--spiders
ISOPODA--sow bugs
DIPLOPODA--millipeds

Table 3-66C. Trophic levels of invertebrates collected in abundance from eastern portion of forest stand of Blue Heron Rookery Unit.

HERBIVORES
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Elateridae--click beetles
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths
- Cecidomyiidae--gall gnats

PREDATORS
- Lampyridae--fireflies
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Nitidulidae--sap beetles
- Chironomidae--midges
- Phoridae--humpbacked flies
- Isopoda--sow bugs
- Diplopoda--millipeds

PARASITES
- Ichneumonidae--ichneumon wasps

An oak savannah community is developed on the sandy beach ridges which form the topographically higher elements of the area. This community type is coded F-2 on the land use map. It includes Bacone's black oak forest, dry oak savannah, dry-mesic oak savannah, dry prairie, and dry-mesic prairie. Its vegetation is ranked in Table 3-67. Black oak is the dominant tree species; it is given a stratum rank of 7, rather than 8 which it would otherwise receive, because of the openness of the canopy. In the absence of severe fire in recent years the canopy is more closed in some places than is typical of oak savannah. The other tree species present, white oak, is found primarily in the lower, more mesic areas. Lowbrush blueberry is the most important shrub; among its common associtates is sweet-fern, a plant not otherwise common in the national lakeshore. The most important herbs are northern bedstraw and bracken fern. Bracken fern is an important herb in many of the previously described black oak communities. Northern bedstraw is unusual in that it thrives in most meadows (as will be noted below) and in prairies. Other herbs, though not of high stratum rank, are of significance in that they are characteristic of dry and dry-mesic prairies: hoary puccoon, lupine, lead-plant, goat's-rue, wild-indigo, rattlesnake-master, rosinweed, downy sunflower, bushy pinweed, rough blazing-star, showy goldenrod, round-headed and hairy bush-clover, wild quinine, and Indian grass. These herbaceous species are especially abundant in openings within the savannah and along its edges and can be expected to increase in importance following fires, whether accidental or planned, which would reduce the abundance of trees and shrubs. Open canopy black oak communities described above lying east and west of County Line Road in the West Unit and east of Mineral Springs Road in the Cowles Unit are rather similar to the savannah of Hoosier Prairie; they are not as rich, however, in these plants characteristic of prairies.

Lying between most of the savannah tracts (coded F-2) of Hoosier Prairie are relatively large expanses coded B-1 on the land use map. When these areas are examined in the field it becomes apparent that at least two distinct community types must be recognized here. 1) On the gentle slopes extending from the savannahs, and covering the majority of the B-1 area, is mesic prairie. This includes Bacone's dry-mesic prairie, mesic prairie, and wet-mesic prairie types. (Note that it is impossible, in our minds and/or for the Hoosier Prairie, to draw sharp lines of distinction; thus dry-mesic prairie is listed both here and in the previous category, and wet-mesic prairie will be listed in the next category as well as here.) 2) In low areas toward the center of B-1 areas the substrate is quite wet, and here is developed wet prairie, often referred to as sedge meadow. This includes Bacone's wet-mesic prairie and wet prairie.

The vegetation of the mesic prairie portion of the area coded B-1 is ranked in Table 3-68. Trees are not present, but there are many saplings of willow, cottonwood, aspen, and even black oak, as well as a large variety of shrubs. Such saplings reflect the fact that fire has not been a factor in regulating the growth of this community in recent years; if this should continue these saplings would grow into trees and shade out much of the prairie vegetation. The Indiana Division of Nature Preserves has within the last few years undertaken

Table 3-67. Stratum ranks of plant species of oak savannah portions of Hoosier Prairie.

Quercus velutina black oak	7	Trees
Quercus alba white oak	3	
Vaccinium angustifolium laevifolium lowbush blueberry	5	Shrubs
Aronia melanocarpa black chokeberry	4	
Cornus sp. dogwood	4	
Comptonia asplenifolia sweet-fern	4	
Rubus sp. rasp- black- berry	4	
Rhus glabra smooth sumac	4	
Ceanothus americanus New Jersey tea	3	
Gaylussacia baccata huckleberry	3	
Rosa blanda meadow rose	3	
Rhus copallina shining sumac	3	
Vitis sp. wild grape	3	
Corylus americana hazelnut	2	
Prunus serotina black cherry	2	
Rhus radicans poison-ivy	2	
Oxalis violacea purple oxalis	4	Herbs 29 May 79
Arenaria lateriflora wood sandwort	3	
Claytonia virginica spring-beauty	3	
Houstonia caerulea bluets	3	
Lithospermum canescens hoary puccoon	3	
Lupinus perennis lupine	3	
Potentilla simplex common cinquefoil	3	
Sisyrinchium albidum common blue-eyed grass	3	
Senecio pauperculus balsam ragwort	3	

Table 3-67 continued

Zizia aurea golden Alexanders	3	
Amorpha canescens lead-plant	2	
Hypoxis hirsuta stargrass	2	
Maianthemum canadense false lily-of-the-valley	2	
Pedicularis canadensis lousewort	2	
Phlox pilosa downy phlox	2	
Smilacina stellata starry false Solomon's-seal	2	
Tephrosia virginiana goat's-rue	2	
Isopyrum biternatum false rue anemone	1	
Phlox divaricata blue phlox	1	
Viola sagittata arrow-leaved violet	1	
Galium boreale northern bedstraw	6	12 July 78
Pteridium aquilinum latiusculum bracken fern	5	
Aralia nudicaulis wild sarsaparilla	4	
Smilacina racemosa false Solomon's-seal	4	
Apios americana groundnut	3	
Baptisia leucantha wild-indigo	3	
Apocynum androsaemifolium spreading dogbane	3	
Prenanthes sp. rattlesnake-root	3	
Tradescantia ohiensis common spiderwort	3	
Achillea millefolium yarrow	2	
Desmodium glutinosum pointed-leaved tick-trefoil	2	
Coreopsis tripteris tall coreopsis	2	
Euphorbia corollata flowering spurge	2	

Table 3-67 continued

Eryngium yuccifolium rattlesnake-master	2	
Rubus hispidus dewberry	2	
Silphium integrifolium rosinweed	2	
Veronicastrum virginicum Culver's root	1	
Asparagus officinalis asparagus	1	
Solidago graminifolia grass-leaved goldenrod	4	19 Sept. 79
Solidago speciosa showy goldenrod	4	
Aster azureus azure aster	3	
Aster ericoides heath aster	3	
Helianthus divaricatus woodland sunflower	3	
Helianthus mollis downy sunflower	3	
Lechea stricta bushy pinweed	3	
Liatris aspera rough blazing-star	3	
Panicum sp. panic-grass	3	
Solidago altissima tall goldenrod	2	
Solidago nemoralis gray goldenrod	2	
Lespedeza capitata round-headed bush-clover	2	
Lespedeza hirta hairy bush-clover	2	
Parthenium integrifolium wild quinine	2	
Polygala sanguinea field milkwort	2	
Sorghastrum nutans Indian grass	2	
Silene stellata starry campion	1	

Table 3-68. Stratum ranks of plant species of mesic prairie portions of Hoosier Prairie.

Salix spp. willow shrubs	5	Shrubs
Aronia melanocarpa black chokeberry	4	
Populus deltoides cottonwood	4	
Populus tremuloides quaking aspen	4	
Spiraea alba meadow-sweet	4	
Cornus sp. dogwood	3	
Quercus velutina black oak	3	
Rhus glabra smooth sumac	3	
Rubus sp. rasp- black- berry	3	
Spiraea tomentosa hardhack	3	
Comptonia asplenifolia sweet-fern	2	
Rosa carolina pasture rose	2	
Corylus americana hazelnut	1	
Houstonia caerulea bluets	5	Herbs 29 May 79
Hypoxis hirsuta stargrass	4	
Potentilla simplex common cinquefoil	4	
Arenaria lateriflora wood sandwort	3	
Dodecatheon meadia shooting-star	3	
Fragaria virginiana strawberry	3	
Osmunda cinnamomea cinnamon fern	3	
Osmunda regalis spectabilis royal fern	3	
Pedicularis canadensis lousewort	3	
Pteridium aquilinum latiusculum bracken fern	3	
Saxifraga pensylvanica Pennsylvania saxifrage	3	

Table 3-68 continued

Senecio pauperculus balsam ragwort	3	
Sisyrinchium albidum common blue-eyed grass	3	
Thalictrum dasycarpum purple meadowrue	3	
Equisetum arvense field horsetail	2	
Erigeron philadelphicus common fleabane	2	
Lithospermum caroliniense hairy puccoon	2	
Lupinus perennis lupine	2	
Maianthemum canadense false lily-of-the-valley	2	
Oxalis violacea purple oxalis	2	
Silphium terebinthinaceum prairie-dock	2	
Smilacina racemosa false Solomon's-seal	2	
Zizia aurea golden Alexanders	2	
Comandra richardsiana false toadflax	1	
Erigeron strigosus narrow-leaved daisy fleabane	1	
Krigia biflora two-flowered dwarf dandelion	1	
Baptisia leucantha wild-indigo	5	12 July 78
Calamogrostis canadensis bluejoint	5	
Parthenium integrifolium wild quinine	5	
Pycnanthemum virginianum common mountain-mint	5	
Silphium integrifolium rosinweed	5	
Thelypteris palustris pubescens marsh fern	5	
Apocynum sibiricum Siberian dogbane	4	

Table 3-68 continued

Eryngium yuccifolium rattlesnake-master	4
Eupatorium perfoliatum common boneset	4
Galium boreale northern bedstraw	4
Iris virginica shrevei wild iris	4
Onoclea sensibilis sensitive fern	4
Rudbeckia hirta black-eyed Susan	4
Carex stricta erect sedge	3
Heuchera richardsonii Richardson alumroot	3
Lythrum alatum wing-angled loosestrife	3
Phlox pilosa downy phlox	3
Spartina pectinata cordgrass	3
Achillea millefolium yarrow	2
Apios americana groundnut	2
Asclepias incarnata swamp milkweed	2
Carex buxbaumii Buxbaum sedge	2
Circuta maculata water-hemlock	2
Coreopsis tripteris tall coreopsis	2
Eleocharis smallii marsh spikerush	2
Erigeron annuus daisy fleabane	2
Euphorbia corollata flowering spurge	2
Lilium michiganense Turk's-cap lily	2
Lilium philadelphicum var. andinum wood lily	2
Lycopus americanus American bugle-weed	2
Polygala sanguinea field milkwort	2
Polygonum amphibium stipulaceum water smartweed	2

Table 3-68 continued

Sporobolus heterolepsis dropseed	2	
Stachys tenuifolia tenuifolia smooth hedge-nettle	2	
Tradescantia ohiensis common spiderwort	2	
Veronicastrum virginicum Culver's root	2	
Amorpha canescens lead-plant	1	
Amphicarpa bracteata hog-peanut	1	
Epilobium angustifolium fireweed	1	
Oenothera pilosella prairie sundrops	1	
Rumex sp. dock	1	
Silphium terebinthinaceum prairie-dock	1	
Solidago altissima tall goldenrod	6	19 Sept. 79
Andropogon gerardi big bluestem	5	
Helianthus grosseserratus sawtooth sunflower	5	
Solidago graminifolia grass-leaved goldenrod	5	
Solidago gymnospermoides lance-leaved goldenrod	5	
Aster ericoides heath aster	4	
Aster umbellatus flat-topped white aster	4	
Aster novae-angliae New England aster	3	
Coreopsis palmata stiff coreopsis	3	
Helianthus mollis downy sunflower	3	
Liatris spicata dense blazing-star	3	
Sorghastrum nutans Indian grass	3	
Aster azureus azure aster	2	
Aster dumosus bushy aster	2	
Bidens coronata crowned tickseed-sunflower	2	
Cirsium discolor field thistle	2	
Gentiana saponiara soapwort gentian	2	
Helianthus divaricatus woodland sunflower	2	
Penthorum sedoides ditch stonecrop	2	
Verbena hastata blue vervain	2	
Gerardia purpurea purple geradia	1	
Polygala cruciata aquilonia marsh milkwort	1	

a program of controlled burning so as to maintain and enhance the prairie character of Hoosier Prairie. An impressive list of ninety species of herbs was found here. Bluets are the most important herb in the spring. Bluejoint grass shares dominance with the forbs wild indigo, wild quinine, rosinweed, common mountain-mint, and marsh fern in the summer. Tall goldenrod is the most important herbaceous plant in the fall, but shares dominance with big bluestem grass, sawtooth sunflower, and grass-leaved and lance-leaved goldenrod. Big bluestem is a typical dominant of mesic prairie, and bluejoint is a typical dominant of wet-mesic prairie. Again there are additional herbaceous species which, though they may not be of high stratum rank, are of significance in that they are characteristic of mesic and wet-mesic prairies. Characteristic of mesic prairie are plants such as black chokeberry, Indian grass, dropseed, flat-topped white aster, wild quinine, lead plant, prairie-dock, wild indigo, rattlesnake-master, and sawtooth and downy sunflower. Characteristic of wet-mesic prairies are plants such as cinnamon fern, royal fern, common mountain-mint, wing-angled loosestrife, golden Alexanders, and Turk's-cap lily.

The vegetation of the wet prairie portion of the area coded B-1 is ranked in Table 3-69. Numerous patches of this community type are scattered through the area coded B-1, wherever there are low spots; no attempt was made to map this detail. As in the mesic prairie within which these patches lie, there are numerous saplings of willow and aspen present; black oak saplings, however, are absent on these wet substrates. Cordgrass, bluejoint grass, and erect sedge are the dominant herbaceous plants. In a long swale which lies toward the center of the large B-1 area north of Main Street these three species share dominance equally, each being ranked at 7. The more usual situation is that in a given patch only one or two species is dominant, the others having a lower rank or not present; for example, cordgrass 8, erect sedge 3; or erect sedge 7, cordgrass 4; or bluejoint 9. Marsh fern is found in virtually every patch in abundance. The other species of herbs listed are much more scattered in their distribution.

Another large expanse of area in Hoosier Prairie is coded C-2; grasses and shrubs on wet substrates. As indicated above in the discussion of the two types of communities recognized in the B-1 areas, there are numerous saplings, particularly of willow and aspen, present in the areas which are dominated by herbaceous vegetation. And it was pointed out there that in the absence of fire such saplings become larger and more numerous. Areas coded C-2 are those in which such a development has occurred. Aspen-willow thickets cover these areas. And areas coded F-3 are those in which this process has gone on sufficiently long for some of the saplings to have reached tree size, but aspen and willow are still the dominant plants and form dense thickets. Included in our aspen-willow thicket category are Bacone's aspen-willow thickets and shrub swamp categories. In most cases the thickets are so dense that shade and competition for water and space have severely depleted the population of prairie species. An exception is found along the eastern margin of Hoosier Prairie south of Main Street. At that location is found the vegetation ranked in Table 3-70.

Table 3-69. Stratum ranks of plant species of wet prairie portions of Hoosier Prairie.

Populus tremuloides quaking apsen	6	Shrubs
Salix spp. willow shrubs	6	
Spiraea alba meadow-sweet	4	
Calamogrostis canadensis bluejoint	6	Herbs 12 July 78
Carex stricta erect sedge	6	
Spartina pectinata cordgrass	6	
Thelypteris palustris pubescens marsh fern	5	
Eleocharis smallii marsh spikerush	4	
Polygonum sp. knotweed, smartweed	4	
Bidens frondosa beggar-ticks	3	
Eupatorium perfoliatum common boneset	3	
Iris virginica shrevei wild iris	3	
Lythrum alatum wing-angled loosestrife	3	
Dulichium arundinaceum three-way sedge	2	
Lysimachia terrestris yellow loosestrife	2	
Osmunda regalis spectabilis royal fern	2	
Scirpus cyperinus wool-grass	2	
Sium suave water-parsnip	2	

Table 3-70. Stratum ranks of plant species of open aspen-willow thicket along eastern margin of Hoosier Prairie south of Main Street--SE¼ NE¼ NW¼, section 3, T 35 N, R 9 W.

Salix spp. willow shrubs	6	Shrubs
Populus tremuloides quaking aspen	4	
Populus deltoides cottonwood	3	
Spiraea alba meadow-sweet	3	
Calamogrostis canadensis bluejoint	7	Herbs 19 Sept. 79
Spartina pectinata cordgrass	7	
Coreopsis palmata stiff coreopsis	5	
Helianthus grosseserratus sawtooth sunflower	5	
Parthenium integrifolium wild quinine	5	
Solidago altissima tall goldenrod	5	
Solidago gymnospermoides lance-leaved goldenrod	5	
Andropogon gerardi big bluestem	4	
Baptisia leucantha wild-indigo	4	
Helianthus mollis downy sunflower	4	
Liatris spicata dense blazing-star	4	
Panicum sp. panic-grass	4	
Pycnanthemum tenuifolium slender mountain-mint	4	
Aster azureus azure aster	3	
Aster ericoides heath aster	3	
Helianthus divaricatus woodland sunflower	3	
Sium suave water-parsnip	3	
Solidago nemoralis gray goldenrod	3	
Sorghastrum nutans Indian grass	3	
Sporobolus heterolepsis dropseed	3	
Veronicastrum virginicum Culver's root	3	
Aster dumosus bushy aster	2	
Gentiana saponaria soapwort gentian	2	
Gerardia purpurea purple gerardia	2	
Iris virginica shrevei wild iris	2	
Lilium michiganense Turk's-cap lily	2	
Prenanthes racemosa smooth white lettuce	2	
Thalictrum dasycarpum purple meadowrue	2	
Verbena hastata blue vervain	2	
Cuscuta cephalanthi buttonbush dodder	1	

Willow and aspen saplings are present, but in this particular location are not especially dense. The importance of bluejoint and cordgrass is indicative of the wetness of the substrate. And the importance of stiff coreopsis, sawtooth sunflower, wild quinine, and lance-leaved and tall goldenrod, and the presence of big bluestem, Indian grass, dropseed, wild indigo, downy sunflower, and dense blazing-star --species characteristic of mesic and wet-mesic prairie--indicate that prairie species are thriving. In other portions coded C-2, however, and certainly in areas coded F-3, there is little other than a dense growth of aspen and willow.

Finally it is seen that numerous patches of marsh, coded E-2 on the land use map, are scattered through Hoosier Prairie. The marshes here are not unlike those that will be described in the wetland section below, but it appears appropriate to discuss them in this context so as to provide the complete picture of Hoosier Prairie. The vegetation of the Hoosier Prairie marshes is ranked in Table 3-71. Willow and aspen saplings are important along the margins of the marsh patches and on hummocks within them. The dominant plants of the community, however, are narrowleaf and common cattail. The only other plant species of much importance in the dense growth of cattails is soft-stem bulrush. It should be noted that there are several small patches of cattail and bulrush, not recognizable on the aerial photographs and not mapped, as well as sedge meadow patches scattered in low spots within the areas coded B-1.

In Tables 3-72A and 3-73A are listed the invertebrates collected from the oak-savannah and open willow-thicket portions of Hoosier Prairie. The numbers of families collected on a single date in these two portions of the prairie are 47 and 54 respectively. These numbers are about average for our collections on a single date.

In Tables 3-72B, 3-72C, 3-73B and 3-73C are listed the families found in abundance in these two portions of the prairie and the trophic levels they occupy. Most striking is the number of families which are herbivorous. In addition to leafhoppers, spittlebugs, planthoppers, and several moth families regularly found in previously described invertebrate collections, there are plant bugs, treehoppers, and plantlice in abundance in both portions of the prairie. Long-legged flies and spiders are again among the abundant predators, and ichneumon wasps among the abundant parasites.

Aquatic Communities

Within or adjoining the Indiana Dunes National Lakeshore are several kinds of aquatic communities. Adjoining the lakeshore to the north is Lake Michigan. Flowing through the Blue Heron Rookery and Bailly Units is the Little Calumet River. There is a stream, Dunes Creek, which heads in the large marsh east of Mineral Springs Road and drains water from this marsh to the east. Ditches in the marshy area south of Beverly Shores drain this marsh. There is a large body of water in the West Unit called Long Lake. And finally there are a

Table 3-71. Stratum ranks of plant species of marsh patches of Hoosier Prairie.

Salix spp. willow shrubs	5	Shrubs	
Populus tremuloides quaking aspen	5		
Quercus velutina black oak	3		
Alisma subcordatum heart-shaped water plantain	2	Herbs 29 May 79	
Equisetum arvense field horsetail	2		
Ludwigia alternifolia seedbox	2		
Lysimachia thrysiflora tufted loosestrife	2		
Ranunculus flabellaris yellow water-crowfoot	2		
Typha angustifolia narrowleaf cattail	7	21 July 78	
Scirpus validus soft-stem bulrush	4		
Dulichium arundinaceum three-way sedge	3		
Bidens frondosa beggar-ticks	3	19 Sept. 79	
Calamogrostis canadensis bluejoint	3		
Polygonum sp. knotweed, smartweed	3		
Aster simplex panicled aster	2		
Myriophyllum sp. water-milfoil	2		
Penthorum sedoides ditch stonecrop	2		
Scirpus cyperinus wool-grass	2		
Solidago graminifolia grass-leaved goldenrod	2		

Table 3-72A. Invertebrates taken in samples collected July 23, 1979, from oak savannah portion of Hoosier Prairie. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
COLLEMBOLA			
Isotomidae			1
ORTHOPTERA			
Acrididae	2		
Phasmatidae			
Diapheromera femorata	3		
PSOCOPTERA			
Psocidae		1	
HEMIPTERA			
Miridae			
Adelphocoris sp.	2		
Deraeoceris sp.	3		
Lygus lineolaris	1		
Neolygus sp.	2		
Plagiognathus politus		1	
Nabidae	1		
Pentatomidae	2		
HOMOPTERA			
Membracidae			
Ceresa sp.	1	2	
Cicadellidae			
Chlorotettix sp.	2		
Cicadula sp.		3	
Empoasca sp.	2	2	
Erythroneura sp.		3	
Gyponana sp.	1	1	
Paraphlepsius sp.		1	
Cercopidae			
Philaenus spumarius	3	2	
Flatidae	2	1	
Aphididae	3	2	
COLEOPTERA			
Carabidae			
Stenolophus sp.		1	
Lampyridae			
Photuris pennsylvanica		3	
Cleridae			
Phyllobaenus pallipennis	2		
Phalacridae			
Phalacrus sp.		1	
Nitidulidae			
Epuraea sp.			1
Mordellidae			
Mordella sp.	1		
Chrysomelidae			
Chrysochus auratus	1		
Curculionidae	3	2	

Table 3-72A continued

	netting/ sweeping	light traps	from litter
NEUROPTERA			
Chrysopidae	3		
LEPIDOPTERA			
Noctuidae	2		
Mamestra sp.		2	
Micromoths		3	
DIPTERA			
Tipulidae	2	2	
Psychodidae		1	
Chaoboridae		2	
Chironomidae		3	
Culicidae	1	4	
Sciaridae		2	
Rhagionidae	1		
Phoridae		1	
Empididae			
Hybos sp.	1		
Syndas sp.	2		
Dolichopodidae		1	
Condylostylus sp.	1		
Dolichopus sp.	2		
Sciaphus sp.	1		
Pipunculidae			
Pipunculus sp.	3		
Platystomatidae			
Rivellia sp.	2		
Lauxaniidae		1	
Calliphoridae	3		
Muscidae	2	1	
HYMENOPTERA			
Braconidae		2	
Ichneumonidae	2	2	
Pteromalidae	3		
Chalcididae		1	
Tiphiidae	1		
Formicidae	4	1	4
PHALANGIDA	3		
ACARINA			3
ARANEIDA	3		

Table 3-72B. Invertebrates taken in abundance from oak savannah portions of Hoosier Prairie.

ORTHOPTERA
- Phasmatidae--walking sticks

HEMIPTERA
- Miridae--plant bugs

HOMOPTERA
- Membracidae--treehoppers
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Flatidae--planthoppers
- Aphididae--plantlice

COLEOPTERA
- Lampyridae--fireflies
- Curculionidae--snout beetles

NEUROPTERA
- Chrysopidae--common lacewings

LEPIDOPTERA
- Noctuidae--miller moths
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chironomidae--midges
- Culicidae--mosquitoes
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Pipunculidae--big-headed flies
- Calliphoridae--blow flies
- Muscidae--muscid flies

HYMENOPTERA
- Ichneumonidae--ichneumon wasps
- Pteromalidae--pteromalid wasps
- Formicidae--ants

PHALANGIDA--daddy-long-legs

ACARINA--mites

ARANEIDA--spiders

Table 3-72C. Trophic levels of invertebrates collected in abundance from oak savannah portions of Hoosier Prairie.

HERBIVORES
- Phasmatidae--walking sticks
- Miridae--plant bugs
- Membracidae--treehoppers
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Flatidae--planthoppers
- Aphididae--plantlice
- Curculionidae--snout beetles
- Noctuidae--miller moths
- Micromoths

PREDATORS
- Lampyridae--fireflies
- Chrysopidae--common lacewings
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Chironomidae

Table 3-73A. Invertebrates taken in samples collected July 23, 1979, from open aspen-willow thicket along eastern margin of Hoosier Prairie--SE¼ NE¼ NW¼, section 3, T 35 N, R 9 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
ODONATA			
Lestidae			
Lestes rectangularis	1		
ORTHOPTERA			
Acrididae		3	
Melanoplus sp.	3		
Tetigoniidae		1	
Conocephalus sp.	2		
Neoconocephalus sp.	2		
Phasmatidae			
Diapheromera femorata	2		
HEMIPTERA			
Miridae			
Lygus lineolaris	2	1	
Plagiognathus politus	2	2	
Trigonotylus sp.		1	
Nabidae	3		
Nabis sp.	1		
Tingidae			
Physatocheila sp.	1		
Lygaeidae			
Cymus sp.	3		
HOMOPTERA			
Membracidae			
Ceresa sp.	2	1	
Cicadellidae			1
Chlorotettix sp.		2	
Draeculacephala sp.	1	2	
Empoasca sp.	3	3	
Scaphoideus sp.	2	2	
Dictyopharidae	1		
Scolops sp.	2		
Psyllidae	1		
Aphididae	3		
COLEOPTERA			
Carabidae			
Lebia sp.	1		
Staphylinidae			1
Lampyridae			
Photuris pennsylvanica		1	
Dermestidae			1
Elateridae			
Athous sp.		1	
Limonius interstitialis		1	
Helodidae			
Cyphon sp.		1	

Table 3-73A continued

	netting/ sweeping	light traps	from litter
COLEOPTERA-Cont.			
Phalacridae			
Phalacrus sp.	2		
Stilbus sp.	2		
Coccinellidae			
Cycloneda sanguinea	1		
Ceramycidae			
Anoplodera sp.	1		
Chrysomelidae			
Altica sp.	1		
Chalcoides nana	3		
Oedionychus sp.	1		
Systena frontalis		3	
Trirhabda virgata	2		
Zygogramma suturalis	1		
LEPIDOPTERA			
Noctuidae			
Apatela sp.	2	2	
Eustrotia sp.		3	
Geometridae	2		
Tetracis crocallata		2	
Xanthtype coelaria	1		
Pyralidae	2		
Micromoths		2	
DIPTERA			
Tipulidae	1	2	
Psychodidae		2	
Chironomidae	1	3	
Culicidae		4	
Cecidomyiidae		2	
Asilidae		1	
Lonchopteridae			
Lonchoptera sp.	3	3	
Empididae			
Hybos sp.	2		
Dolichopodidae		2	
Dolichopus sp.	2		
Sciaphus sp.	2		
Psilidae		1	
Syrphidae	2		
Otitidae			
Chaetopsis sp.	2		
Tephritidae	2		
Sepsidae	2		
Lauxaniidae	1		
Sapromyza sp.	3		
Drosophilidae	2		
Chloropidae			
Chlorops sp.	2		
Oscinella sp.		4	
Calliphoridae	2	2	
Muscidae	3	2	
HYMENOPTERA			
Braconidae			1
Ichneumonidae	1		
Torymidae		1	
Eurytomidae	1		
Apidae			
Apis mellifera	2		
PHALANGIDA	2		
ACARINA			3
ARANEIDA	3		2

Table 3-73B. Invertebrates taken in abundance from open aspen-willow thicket along eastern margin of Hoosier Prairie.

ORTHOPTERA
- Acrididae--short-horned grasshoppers
- Tetigoniidae--long-horned grasshoppers

HEMIPTERA
- Miridae--plant bugs
- Nabidae--damsel bugs
- Lygaeidae--seed bugs

HOMOPTERA
- Membracidae--treehoppers
- Cicadellidae--leafhoppers
- Dictyopharidae--planthoppers
- Aphididae--plantlice

COLEOPTERA
- Phalacridae--shining flower beetles
- Chrysomelidae--leaf beetles

LEPIDOPTERA
- Noctuidae--miller moths
- Geometridae--measuringworms

DIPTERA
- Tipulidae--crane flies
- Chironomidae--midges
- Culicidae--mosquitoes
- Lonchopteridae--spear-winged flies
- Dolichopodidae--long-legged flies
- Lauxaniidae--lauxaniids
- Chloropidae--frit flies
- Calliphoridae--blow flies
- Muscidae--muscid flies

ACARINA--mites

ARANEIDA--spiders

Table 3-73C. Trophic levels of invertebrates collected in abundance from open aspen-willow thicket along eastern margin of Hoosier Prairie.

HERBIVORES
- Acrididae--short-horned grasshoppers
- Tetigoniidae--long-horned grasshoppers
- Miridae--plant bugs
- Lygaeidae--seed bugs
- Membracidae--treehoppers
- Cicadellidae--leafhoppers
- Dictyopharidae--planthoppers
- Aphididae--plantlice
- Chrysomelidae--leaf beetles
- Noctuidae--miller moths
- Geometridae--measuringworms

PREDATORS
- Nabidae--damsel bugs
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Chironomidae--midges
- Calliphoridae--blow flies

number of small ponds in the West Unit and Cowles Unit, and one west of Pinhook Bog.

The aquatic communities we sampled were Long Lake, some of the ponds in the West Unit and Cowles Unit, the pond near Pinhook Bog and the Little Calumet River. Before listing and commenting on the organisms found in our sampling, something should be said about the nature of some of these bodies of water. On the topographic maps and the land use maps of chapter 2 it is seen that there is a low-lying, marshy area just north of the South Shore railroad tracks across the eastern two-thirds of Porter county and again on either side of the Lake-Porter county line. Forming the southern margin of the marsh basin in the eastern part of Porter county is the Calumet beach ridge which is followed by the South Shore tracks and U.S. 12. At the time this was the lakeshore the lake bottom at this locality sloped gradually downward to the north. Since that time Tolleston, Algonquin, and more recent dunes have formed a few thousand feet to the north. To the west in Porter county and into Lake county it is the Tolleston and Algonquin beach ridges which form the southern margin of the marsh basin and which are followed by the South Shore tracks and U.S. 12. Again more recent dunes have developed to the north. In both cases as dunes were formed some distance to the north of previous beach ridges basins were created. Basins formed in this way--that is, between dune ridges of different ages--are referred to as interdunal, and ponds in such basins are interdunal ponds.

In the West Unit a number of ponds lie just a few hundred feet south of Lake Michigan in depressions formed by blowout activity. Several thousand feet farther to the south in the southwestern portion of the West Unit there is a rather large expanse of swell and swale topography. The swells are ridges of beach and dune sand of post-Nipissing-Algoma age. An embayment of Lake Michigan appears to have existed in this area. Sand accumulating in the embayment was shaped by the action of water, wind, and vegetation into a series of ridges which built up in a northward direction until the southern shore of Lake Michigan formed an unbroken arc. Between the ridges are depressions or swales within which are ponds and/or wetland communities. Basins formed within dunes of the same age, as those are which are described in this paragraph, and the ponds within them, are referred to as intradunal.

Pinhook Bog is developed in a basin in the glacial till of the Valparaiso moraine. In a shallow extension of this basin to the west there is a small pond.

Thus, there are ponds of several types represented in the national lakeshore. The U.S.G.S. topographic maps show most of these ponds and marshes. The land use map, however, in its greater detail shows that there is regularly open water (E-1) present in addition to marsh (E-2).

Whether a given basin has little expanse of open water and is considered a marsh, or has open water the year around and is considered a pond, or has open water only part of the year and is considered a seasonal pond depends upon a number of variables and may actually differ from year to year. Variations in Lake Michigan level, modifications of drainage patterns, and the temperature and precipitation conditions are some obvious factors. For purposes of this study those basins which had open water in July and August of the years in which we did our sampling are considered ponds and are described as such below.

West Unit intradunal ponds -- There are intradunal ponds in the West Unit where it adjoins Lake Michigan both to the east and the west.

Immediately behind the foredunes in the eastern portion of the West Unit there are numerous depressions containing ponds. Five major depressions are recognized when the U.S.G.S. topographic map with 10 foot contour intervals is examined. As a matter of fact the ponds occupy small depressions within the major ones. With variations in water level because of differences in precipitation from year to year, lake level, and seasonal differences there are variations in the extent and number of ponds. What a high water level is one large pond becomes several small ones at low water level. Thus the land use map shows on the order of twenty ponds in this area. On examination, however, the pods of a major depression were seen to be quite similar in their vegetation and there is no reason why they should not be. On the other hand water level variations are limited so that there is little if any likelihood of water of the major depressions becoming interconnected. In view of these considerations, and to make our work manageable, we studied one of the larger ponds in each of the five major depressions.

Organisms recorded from these ponds, beginning at the east and proceeding westward, are presented in Tables 3-74 through 3-78. Part A of each table gives the ranks of the vegetation in and round the ponds; those plants are listed as emergent are rooted in the water but extend above its surface; those listed as aquatic are found in or floating upon the water. Part B presents counts of the plankta from a measured sample; it should be noted that the only number which indicates density is the last one given: the calculated number of plankta per liter. Part C gives counts of the macroscopic animals collected from the littoral zone. The techniques were discussed earlier in this chapter.

The two ponds to the east and that to the west have a rather rich marginal vegetation as well as a rich growth of emergent and aquatic plants. The remaining two ponds have a great deal of bare sand at their margins and are much less choked with emergent and aquatic plants. Undoubtedly these ponds are different stages of succession and this accounts for these differences. A newly formed depression below the water table would consist simply of a sandy basin filled with water. The two ponds with a great deal of bare sand at their margins and with

Table 3-74A. Ranks of vegetation in and around the easternmost intradunal pond of West Unit west of Ogden Dunes--NE¼ SE¼ SE¼, section 27, T 37 N, R 7 W.

Hypericum kalmianum Kalm's St.-John's-wort	4	Marginal Shrubs
Salix spp. willow shrubs	4	
Salix syrticola dune willow	4	
Lobelia kalmii Kalm lobelia	4	Herbs
Sabatia angularis rose-pink	4	
Aster ptarmicoides upland white aster	3	
Coreopsis lanceolata lance-leaved coreopsis	1	
Eleocharis acicularis needle spikerush	7	Emergent
Rhynchospora capillacea hair-like beakrush	7	
Juncus brevicaudatus short-tailed rush	5	
Carex viridula greenish sedge	4	
Juncus balticus littoralis lakeshore rush	3	
Scirpus validus soft-stem bulrush	3	
Typha latifolia common cattail	3	
Chara contraria stonewort	8	Aquatic
Utricularia cornuta horned bladderwort	5	
Potamogeton gramineus variable pondweed	2	

Table 3-74B. Counts of plankta in measured sample from the easternmost intradunal pond of West Unit west of Ogden Dunes--NE¼ SE¼ SE¼, section 27, T 37 N, R 7 W.

unicellular green algae	
Ankistrodesmus	4
others	1
filamentous green algae	5
colonial blue-green algae	2
unicellular desmids	4
diatoms	18

Total count in 0.25 ml sample: 34

30 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 142

Table 3-74C. Counts of macroscopic animals collected in half hour from littoral zone of the easternmost intradunal pond of West Unit west of Odgen Dunes--NE¼ SE¼ SE¼, section 27, T 37 N, R 7 W.

Odonata	
Libellulidae (dragonflies), numphs	2
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	8
Hemiptera	
Corixidae (water boatmen)	2
Nepidae (water scorpions), Ranatra sp.	1
Gerridae (water striders), Gerris marginatus	2
Mesoveliidae (water treaders), Mesovelia mulsanti	6
Mollusca	
Lymnaeidae (pond snails), Lymnaea sp.	5
Total:	26

Table 3-75A. Ranks of vegetation in and around the second from the east intradunal pond of West Unit west of Odgen Dunes--center of S margin of NW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.

Hypericum kalmianum Kalm's St.-John's-wort	4	Marginal Shrubs
Salix spp. willow shrubs	3	
Aster ptarmicoides upland white aster	3	Herbs
Lobelia kalmii Kalm lobelia	3	
Sabatia angularis rose-pink	3	
Liparis loeselii bog twayblade	1	
Rhynchospora capillacea hair-like beakrush	7	Emergent
Juncus balticus littoralis lakeshore rush	6	
Carex viridula greenish sedge	3	
Eleocharis acicularis needle spikerush	3	
Juncus brevicaudatus short-tailed rush	3	
Typha latifolia common cattail	2	
Chara contraria stonewort	8	Aquatic
Utricularia cornuta horned bladderwort	4	
Chara keukensis stonewort	3	
Najas flexilis naiad	3	
Potamogeton amplifolius large-leaved pondweed	3	
Potamogeton gramineus variable pondweed	3	
Potamogeton natans floating-leaf pondweed	3	
Potamogeton sp. pondweed	3	

Table 3-75C. Counts of macroscopic animals collected in half hour from littoral zone of the second from the east intradunal pond of West Unit west of Ogden Dunes--center of S margin of NW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.

Odonata	
Libellulidae (dragonflies), nymphs	2
Aeschnidae (dragonflies), nymphs	1
Coenagrionidae (damselflies)	
Ischnura sp., nymphs	12
Enallagma sp., nymphs	3
Hemiptera	
Notonectidae (backswimmers)	
Notonecta undulata	14
Buenoa sp.	2
Gerridae (water striders), Gerris marginatus	2
Mesoveliidae (water treaders), Mesovelia mulsanti	5
Hebridae (velvet water bugs), Merragata sp.	2
Coleoptera	
Gyrinidae (whirligig beetles)	
Dineutes assimilis	2
Gyrinus sp.	1
Hydrophilidae (water scavenger beetles), larva	1
Chrysomelidae (leaf beetles), Gelerucella sp.	1
Amphipoda	
Gammaridae (scuds), Gammarus sp.	4
Hydracarina (water mites)	1
Mollusca	
Lymnaeidae (pond snails), Lymnaea sp.	2
Total:	55

Table 3-75B. Counts of plankta in measured sample from the second from the east intradunal pond of West Unit west of Odgen Dunes--center of S margin of NW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.

unicellular green algae	
Ankistrodesmus	6
filamentous green algae	4
dinoflagellates	1
unicellular desmids	2
diatoms	10
protozoa	
Difflugia	1
nauplius larvae	1

Total count in 0.25 ml sample: 25

30 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 104

Table 3-76A. Ranks of vegetation in and around the middle intradunal pond of West Unit west of Ogden Dunes--center of W margin of SW¼ SW¼ SE¼, section 27, T 37 N, R 7 W.

Juncus brevicaudatus short-tailed rush	5	Emergent
Eleocharis acicularis needle spikerush	4	
Juncus balticus littoralis lakeshore rush	3	
Scirpus validus soft-stem bulrush	3	
Typha latifolia common cattail	2	
Chara contraria stonewort	6	Aquatic
Chara keukensis stonewort	3	
Potamogeton gramineus variable pondweed	3	
Potamogeton sp. pondweed	3	

Table 3-76B. Counts of plankta in measured sample from the middle intradunal pond of West Unit west of Ogden Dunes--center of W margin of SW¼ SE¼ SE¼, section 27, T 37 N, R 7 W.

unicellular green algae	
Ankistrodesmus	5
filamentous green algae	
Spirogyra, Zygnema, etc.	17
colonial blue-green algae	
Merismopedia, etc.	9
unicellular desmids	
Staurastrum	1
others	4
diatoms	
Navicula, Amphora, etc.	631
protozoa	
Arcella	1

Total count in 0.25 ml sample: 668

30 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 2783

Table 3-76C. Counts of macroscopic animals collected in half hour from littoral zone of the middle intradunal pond of West Unit west of Ogden Dunes--center of W margin of SW¼ SW¼ SE¼, section 27, T 37 N, R 7 W.

Odonata	
Libellulidae (dragonflies), nymphs	1
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	7
Hemiptera	
Corixidae (water boatmen)	1
Notonectidae (backswimmers), Notonecta undulata	4
Coleoptera	
Gyrinidae (whirlgig beetles) Dineutes assimilis	1
Hydrophilidae (water scavenger beetles)	
Tropisternus nimbatus	4
larvae	3
Amphipoda	
Gammaridae (scuds), Gammarus sp.	2
Mollusca	
Physidae (pouch snails), Physa sp.	1
Hirudinea (leeches)	1
Total:	25

Table 3-77A. Ranks of vegetation in and around the second from the west intradunal pond of West Unit west of Ogden Dunes--center of S½ SE¼ SW¼, section 27, T 37 N, R 7 W.

Salix spp. willow shrubs	4	Marginal Shrubs
Triglochin maritima arrow-grass	1	Herbs
Juncus balticus littoralis lakeshore rush	7	Emergent
Juncus brevicaudatus short-tailed rush	7	
Carex viridula greenish sedge	5	
Rhynchospora capillacea hair-like beakrush	5	
Eleocharis acicularis needle spikerush	3	
Chara contraria stonewort	7	Aquatic
Chara keukensis stonewort	6	

Table 3-77B. Counts of plankta in measured sample from the second from the west intradunal pond of West Unit west of Ogden Dunes--center of S½ SE¼ SW¼, section 27, T 37 N, R 7 W.

unicellular green algae	
Ankistrodesmus	4
filamentous green algae	5
dinoflagellates	2
colonial blue-green algae	2
unicellular desmids	4
diatoms	
Navicula, Amphora, etc.	401

Total count in 0.25 ml sample: 418

30 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 1742

Table 3-77C. Counts of macroscopic animals collected in half hour from littoral zone of the second from the west intradunal pond of West Unit west of Ogden Dunes--center of S½ SE¼ SW¼, section 27, T 37 N, R 7 W.

Odonata	
Libellulidae (dragonflies), nymphs	2
Aeschnidae (dragonflies), nymphs	1
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	6
Hemiptera	
Notonectidae (backswimmers)	
Notonecta undulata	8
Buenoa sp.	2
Gerridae (water striders), Gerris marginatus	2
Mesoveliidae (water treaders), Mesovelia mulsanti	2
Hebridae (velvet water bugs), Merragata sp.	2
Coleoptera	
Hydrophilidae (water scavenger beetles)	
Tropisternus nimbatus	2
larvae	2
Diptera	
Chironomidae (midges), larva	1
Hydracarina (water mites)	1
Amphipoda	
Gammaridae (scuds), Gammarus sp.	2
Mollusca	
Lymnaeidae (pond snails), Lymnaea sp.	2
Total:	35

Table 3-78A. Ranks of vegetation in and around the westernmost intradunal pond of West Unit west of Ogden Dunes--center of S½ SW¼ SW¼, section 27, T 37 N, R 7 W.

Salix spp. willow shrubs	6	Marginal Shrubs
Hypericum kalmianum Kalm's St.-John's-wort	3	
Lobelia kalmii Kalm lobelia	5	Herbs
Centaurium pulchellum centaury	3	
Erigeron annuus daisy fleabane	3	
Fragaria virginiana strawberry	3	
Sabatia angularis rose-pink	3	
Triglochin maritima arrow-grass	3	
Asclepias incarnata swamp milkweed	2	
Epilobium coloratum purple-leaved willow-herb	2	
Lycopus americanus American bugle-weed	2	
Oenothera biennis evening-primrose	2	
Potentilla anserina silverweed	2	
Asclepias verticillata whorled milkweed	1	
Mimulus ringens monkey-flower	1	
Juncus balticus littoralis lakeshore rush	6	Emergent
Typha latifolia common cattail	6	
Juncus brevicaudatus short-tailed rush	5	
Eleocharis acicularis needle spikerush	4	
Rhynchospora capillacea hair-like beakrush	4	
Scirpus acutus hard-stem bulrush	4	
Scirpus americanus sword-grass	4	
Scirpus heterochaetus slender bulrush	2	
Cladium mariscoides twig rush	1	
Chara contraria stonewort	7	Aquatic
Lemna minor lesser duckweed	4	
Potamogeton nodosus long-leaved pondweed	4	
Zannichellia palustris horned pondweed	4	
Utricularia cornuta horned bladderwort	3	
Chara keukensis stonewort	2	
Potamogeton sp. pondweed	2	

Table 3-78B. Counts of plankta in measured sample from the westernmost intradunal pond of West Unit west of Ogden Dunes--center of S½ SW¼ SW¼, section 27, T 37 N, R 7 W.

colonial green algae	
Actinastrum	2
others	2
colonial blue-green algae	
Merismopedia, etc.	6
unicellular desmids	
Cosmarium	11
Staurastrum	2
others	12
filamentous desmids	2
diatoms	
Navicula, Amphora, etc.	19
copepods	1
nauplius larvae	2

Total count in 0.25 ml sample: 59

30 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 246

Table 3-78C. Counts of macroscopic animals collected in half hour from littoral zone of the westernmost intradunal pond of West Unit west of Ogden Dunes--center of S½ SW¼ SW¼, section 27, T 37 N, R 7 W.

Odonata	
Libellulidae (dragonflies), nymphs	5
Coenagrionidae (damselflies), nymphs	18
Hemiptera	
Notonectidae (backswimmers)	
Notonecta undulata	8
Buenoa sp.	1
Nepidae (water scorpions) Ranatra sp.	1
Gerridae (water striders), Gerris marginatus	1
Mesoveliidae (water treaders), Mesovelia mulsanti	1
Amphipoda	
Gammaridae (scuds), Gammarus sp.	16
Mollusca	
Lymnaeidae (pond snails), Lymnaea sp.	14
Total:	65

relatively small amounts of emergent and aquatic plants represent an early stage in succession. The ponds with a rich aquatic and emergent vegetation and a well-developed marginal vegetation represent a later stage in succession. In addition to the obvious absence of plants along the margins of the ponds early in succession, these ponds are distinctive in that the emergent vegetation consists primarily of rushes (Juncus spp.) and spikerushes (Eleocharis spp.); cattail (Typha spp.) and bulrush (Scirpus spp.) are absent or low stratum rank. The emergent vegetation of the two easternmost ponds is also of this type, in contrast to that of the westernmost pond in which common cattail and several species of bulrush are of importance in addition to the rushes and spikerushes. Inasmuch as cattail and bulrush are dominant species in marshes which follow ponds in succession, it appears that the westernmost of these five ponds exhibits the most advanced stage of succession in this portion of the West Unit and that the two ponds farthest to the east represent an intermediate stage. Stoneworts (Chara spp.) are the dominant aquatic species in all five ponds. The two ponds considered to be in an early stage of succession have a much higher plankton count per liter than the other three, the difference being primarily in the large number of diatoms in these two ponds. There is not a great deal of difference in the counts of macroscopic animals. The pond to the west yielded the greatest number per unit effort, but the one second from the east yielded almost as many and a greater variety of organisms. In all five ponds damselfly nymphs are an important component. Scuds and pond snails are next in importance in the westernmost pond. Backswimmers are of much importance in the middle three ponds.

Where the West Unit adjoins Lake Michigan to the west--immediately east of United States Steel property--there are several foredune ridges immediately behind the beach. Behind these ridges there is a blowout complex consisting of numerous mounds of sand established by vegetation, channels of open sand (maintained by vehicular and foot traffic as well as by wind action), and depressions reaching below the water table. Some of the depressions between the foredune ridges are sufficiently close to the water table that a marshy type vegetation--much like that in the panne described above--develops; there is not sufficient water present, however, for them to be considered ponds. A pond does exist, at NE¼ SE¼ NE¼, section 36, T 37 N, R 8 W, in the depression between a foredune ridge and the open sand of a blowout. Organisms identified in and around this pond are listed and/or ranked in Table 3-79. The dominance of cattails and soft-stem bulrush in the emergent zone and the variety of plants (including several woody species) along the margin of the pond indicate that this pond is at an even later stage of succession than any of the five west of Ogden Dunes. Chara is again the dominant aquatic species.

Other ponds in this portion of the West Unit lie in depressions in the blowout complex. The organisms in and around a pond immediately east of a United States Steel slag pile, at SE¼ SE¼ NE¼, section 36, T 37 N, R 8 W, are listed and/or ranked in Table 3-80. The organisms in and around a pond just north of the Grand Calumet River, at the center

Table 3-79A. Ranks of vegetation in and around intradunal pond of West Unit east of United States Steel--NE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.

Cornus stolonifera red-osier dogwood	4	Marginal Shrubs
Hypericum kalmianum Kalm's St.-John's-wort	4	
Salix spp. willow shrubs	4	
Asclepias incarnata swamp milkweed	3	Herbs 27 July 78
Carex sp. sedge	3	
Equisetum laevigatum smooth scouring-rush	3	
Lycopus americanus American bugle-weed	3	
Alisma triviale common water-plantain	2	
Lythrum alatum wing-angled loosestrife	2	
Triglochin maritima arrow-grass	2	
Aster ericoides heath aster	5	15 Sept. 79
Eupatorium altissimum tall boneset	4	
Gerardia purpurea purple gerardia	4	
Solidago altissima tall goldenrod	4	
Solidago graminifolia grass-leaved goldenrod	4	
Gentiana crinita fringed gentian	3	
Lobelia kalmii Kalm lobelia	3	
Typha angustifolia narrowleaf cattail	7	Emergent
Eleocharis acicularis needle spikerush	6	
Typha latifolia common cattail	6	
Scirpus validus soft-stem bulrush	5	
Juncus balticus littoralis lakeshore rush	3	
Sagittaria latifolia common arrowhead	3	
Chara sp. stonewort	8	Aquatic
Potamogeton sp. pondweed	3	

Table 3-79B. Counts of plankta in measured sample from intradunal pond of West Unit east of United States Steel--NE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.

colonial green algae	
Volvox	1
Schizochlamys	2
Chlorella	1
filamentous green algae	
Ulothrix	105
Oedogonium	41
colonial blue-green algae	
Microcystis	2
Merismopedia	1
filamentous blue-green algae	
Anabaena	27
Oscillatoria	1
unicellular desmids	
Cosmarium	1
diatoms	
Synedra, Amphora, etc.	20
copepods	1
cladocera	1
nauplius larvae	2
Total count in 0.25 ml sample:	206
25 quarts concentrated into 4 ounces	
Calculated number of plankta per liter:	4120

Table 3-79C. Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of West Unit east of United States Steel--NE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.

Ephemeroptera (mayflies)	
Caenidae, Caenis sp. (nymphs)	6
Odonata	
Aeschnidae (dragonflies), Anax sp. (nymphs)	5
Libellulidae (dragonflies), nymphs	6
Lestidae (damselflies), Lestes sp. (nymphs)	10
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	7
Hemiptera	
Corixidae (water boatmen)	1
Notonectidae (backswimmers), Notonecta sp. (nymphs)	7
Belostomatidae (giant water bugs), nymphs	4
Gerridae (water striders), Gerris buenoi	3
Veliidae (smaller water striders), Microvelia buenoi	10
Mesoveliidae (water treaders), Mesovelia mulsanti	1
Coleoptera	
Hydrophilidae (water scavenger beetles), Tropisternus glaber	1
Dytiscidae (predaceous diving beetles), Hydropus sp.	1
Hydracarina (water mites)	2
Amphipoda	
Gammaridae (scuds), Gammarus sp.	37
Mollusca	
Physidae (pouch snails), Physa sp.	5
Planorbidae (orb snails)	4
Lymnaeidae (pond snails), Lymnaea sp.	5
Sphaeriidae (fingernail clams), Pisidium sp.	6
Total:	121

Table 3-80A. Ranks of vegetation in and around intradunal pond of West Unit east of Unied States Steel slag pile--SE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.

Hypericum kalmianum Kalm's St.-John's-wort	5	Marginal Shrubs
Pinus banksiana jack pine	5	
Salix spp. willow shrubs	4	
Cornus stolonifera red-osier dogwood	4	
Populus deltoides cottonwood	3	
Cornus sp. dogwood	1	
Senecio pauperculus balsam ragwort	5	Herbs 25 May 79
Equisetum hyemale affine common scouring-rush	3	
Calamogrostis inexpansa brevior northern reedgrass	4	27 July 78
Lythrum alatum wing-angled loosestrife	4	
Equisetum variegatum variegated scouring-rush	4	
Triglochin maritima arrow-grass	4	
Alisma subcordatum heart-shaped water-plantain	3	
Equisetum laevigatum smooth scouring-rush	3	
Pycnanthemum virginianum common mountain-mint	3	
Sabatia angularis rose-pink	3	
Asclepias incarnata swamp milkweed	3	
Solidago racemosa gillmani dune goldenrod	5	15 Sept. 79
Aster ericoides heath aster	4	
Aster vimineus small white aster	4	
Gerardia purpurea purple gerardia	4	
Aster umbellatus flat-topped white aster	3	
Lobelia kalmii Kalm lobelia	3	

Table 3-80A continued

Eupatorium perfoliatum common boneset	2	
Gentiana crinita fringed gentian	2	
Lobelia siphilitica great lobelia	2	
Scirpus validus soft-stem bulrush	6	Emergent
Scirpus americanus sword-grass	6	
Typha angustifolia narrowleaf cattail	5	
Juncus balticus littoralis lakeshore rush	4	
Rhynchospora capillacea hair-like beakrush	4	
Cladium mariscoides twig rush	3	
Eleocharis acicularis needle spikerush	3	
Chara sp. stonewort	8	Aquatic
Potamogeton sp. pondweed	6	
Nuphar variegatum bullhead-lily	5	
Utricularia cornuta horned bladderwort	2	

Table 3-80B. Counts of plankta in measured sample from intradunal pond of West Unit east of United States Steel slag pile -- SE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.

filamentous green algae	
Ulothrix	6
colonial blue-green algae	
Microcystis	31
filamentous blue-green algae	
Anabaena	2500±
Oscillatoria	5
Spirulina	2
unicellular desmids	
Microasterias	1
diatoms	
Navicula, etc.	8
protozoa	
Arcella	7
copepods	1
Nauplius larvae	2

Total count in 0.25 ml sample: 2563

25 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 12,815

Table 3-80C. Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of West Unit east of United States Steel slag pile--SE¼ SE¼ NE¼, section 36, T 37 N, R 8 W.

Odonata	
Aeschnidae (dragonflies), Anax sp. (nymph)	1
Libellulidae (dragonflies), nymphs	3
Hemiptera	
Gerridae (water striders), Gerris buenoi	3
Mesoveliidae (water treaders), Mesovelia mulsanti	10
Coleoptera	
Gyrinidae (whirligig beetles), Dineutes hornii	4
Hydrophilidae (water scavenger beetles)	
Berosus sp.	2
Helophorus sp.	1
Haliplidae (crawling water beetles), Peltodytes 12-punctatus	1
Decapoda	
Astacidae (crayfish), Cambarus sp.	1
Amphibia	
Ranidae (frogs), Rana sp. tadpoles	2
Total:	28

of SW¼ NW¼, section 31, T 37 N, R 7 W, are listed in Table 3-81. In both cases there are many plants species, both woody and herbaceous, along the margins. The vegetation around the pond east of the slag pile is a bit more dense, with four species given a SR of 5: the woody Kalm's St.-John's-wort and jack pine and the herbaceous balsam ragwort and dune goldenrod. No woody species around the pond north of the Grand Calumet is given a rank above 4; two herbaceous species, arrow grass and dune goldenrod, are ranked at 5. As in the case of the pond described in the preceding paragraph, cattails and bulrushes (Scirpus spp.) are among the most important plants in the emergent zone of these two ponds; but the greater density and diversity of both woody and herbaceous plants along the margins of these two ponds suggest that they are at a somewhat later stage of succession than that one. In both these two ponds stonewort is the most important aquatic plant and pondweeds and bullhead-lily are common associates.

When the plankta counts of these three intradunal ponds of the West Unit east of United States Steel are compared with one another and with those of the five intradunal ponds which lie west of Ogden Dunes, the following items are noted. First of all, the number of organisms per liter in the pond adjacent to the slag pile is much larger than the number in any of the other ponds. On examination it is seen that this higher count is attributable to the large number of Anabaena. This filamentous blue-green alga is listed in Standard Methods (1971) among the algae of polluted waters. Secondly, the counts in the other two ponds east of United States Steel are between 1000 and 5000 per liter, as are the counts of the two ponds west of Ogden Dunes which are the highest. In the ponds west of Ogden Dunes it is the large number of diatoms which is primarily responsible for the size of the counts; in the ponds east of United States Steel there is a variety of organisms responsible for the size of the counts: the filamentous green algae Ulothrix, Oedogonium, and Spirogyra; the filamentous blue-greem algae Anabaena and Oscillatoria; and the diatoms Navicula and Synedra.

When the counts of the macroscopic animals collected in the littoral zones of these ponds of the West Unit east of United States Steel are compared with one another and with those of the five intradunal ponds which lie west of Ogden Dunes, the following items are noted. First of all, the number of organisms taken in the pond east of the United States Steel slag pile is among the lowest in this study. This lowness is aberrant for a pond this late in succession. The pollution indicated by the presence of Anabaena in such large numbers may very well affect, either directly or indirectly (e.g., via food chain relationships) the number of macroscopic animals. The most abundant animals here are forms living on the surface of the water: water treaders, water striders, and whirligig beetles. Secondly, the numbers and variety of macroscopic animals taken in the remaining two ponds east of United States Steel are considerably higher than in even the richest ponds west of Ogden Dunes; in fact, as will be noted when the remaining tables in this section are examined, these are the highest counts we obtained anywhere in the national lakeshore. This confirms

Table 3-81A. Ranks of vegetation in and around intradunal pond of West Unit just north of Grand Calumet River--center of SW¼ NW¼, section 31, T 37 N, R 7 W.

Cornus stolonifera red-osier dogwood	4	Marginal Shrubs	
Populus deltoides cottonwood	4		
Salix spp. willow shrubs	4		
Hypericum kalmianum Kalm's St.-John's-wort	3		
Triglochin maritima arrow-grass	5	Herbs 27 July 78	
Alisma subcordatum heart-shaped water-plantain	3		
Asclepias incarnata swamp milkweed	3		
Lythrum alatum wing-angled loosestrife	3		
Asclepias verticillata whorled milkweed	2		
Pycnanthemum virginianum common mountain-mint	2		
Sabatia angularis rose-pink	2		
Solidago racemosa gillmani dune goldenrod	5	15 Sept. 79	
Aster ericoides heath aster	3		
Aster umbellatus flat-topped white aster	3		
Gentiana crinita fringed gentian	3		
Gerardia purpurea purple gerardia	3		
Lobelia kalmii Kalm lobelia	3		
Panicum virgatum switchgrass	3		
Juncus pelocarpus brown-fruited rush	7	Emergent	
Scirpus americanus sword-grass	5		
Scirpus validus soft-stem bulrush	5		
Typha angustifolia narrowleaf cattail	5		
Juncus balticus littoralis lakeshore rush	4		
Chara sp. stonewort	8	Aquatic	
Potamogeton sp. pondweed	5		
Nuphar variegatum bullhead-lily	3		

Table 3-81B. Counts of plankta in measured sample from intradunal pond of West Unit just north of Grand Calumet River--center of SW¼ NW¼, section 31, T 37 N, R 7 W.

colonial green algae	
pandorina	4
Pleodorina	2
filamentous green algae	
Spirogyra	52
Oedogonium	7
others	3
colonial blue-green algae	
Microcystis	1
filamentous blue-green algae	
Anabaena	7
Oscillatoria	5
unicellular desmids	
Closterium etc.	4
diatoms	
Navicula, Synedra, etc.	42
protozoa	
Vorticella	1
Arcella	2
Difflugia	3
Acanthocystis	1
copepods	2
cladocera	3
ostracods	6
nauplius larvae	1

Total count in 0.25 ml sample: 146

25 quarts concentrated into 2 ounces

Calculated number of plankta per liter: 1460

Table 3-81C. Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of West Unit just north of Grand Calumet River--center of SW¼ NW¼, section 31, T 37 N, R 7 W.

Ephemeroptera (mayflies)	
Caenidae, caenis sp. (nymphs)	5
Odonata	
Aeschnidae (dragonflies), Anax sp. (nymphs)	5
Libellulidae (dragonflies), nymphs	6
Coenagionidae (damselflies), Ischnura sp. (nymphs)	14
Hemiptera	
Notonectidae (backswimmers), Notonecta variabilis	13
Pleidae (pigmy backswimmers), Neoplea striola	13
Nepidae (water scorpions), Ranatra nigra	1
Gerridae (water striders), Gerris buenoi	4
Veliidae (smaller water striders), Microvelia sp.	2
Mesoveliidae (water treaders), Mesovelia mulsanti	12
Coleoptera	
Gyrinidae (whirligig beetles), Dineutes hornii	7
Hydrophilidae (water scavenger beetles), larva	1
Haliplidae (crawling water beetles)	
Peltodytes edentulus	4
Haliplus fasciatus	1
H. triopsis	1
Chrysomelidae (leaf beetles), Donacia sp.	2
Megaloptera	
Sialidae (alder flies), Sialis sp. (larva)	1
Diptera	
Chironomidae (midges), larva	1
Amphipoda	
Gammaridae (scuds), Gammarus sp.	2
Hydracharina (water mites)	47
Mollusca	
Physidae (pouch snails), Physa sp.	4
Planorbidae (orb snails)	20
Lymnaeidae (pond snails)	47
Total:	169

the above suggestion that these ponds east of United States Steel are at a later stage of succession than those west of Ogden Dunes. Scuds are the most abundant macroscopic animals in the pond between the foredunes and the blowout complex, while water mites and orb snails are the most abundant forms in the pond near the Grand Calumet River.

As a result of human modification of its channel, the stretch of the Grand Calumet River which is included in the western portion of the West Unit is essentially a lagoon. To the south the lagoon is bordered by the black oak forest known as Miller Woods. Forming the north border is sand carried in by wind action. Where this sand slopes gradually to the water's edge, particularly around the embayment which extends northward from the lagoon, is the vegetation which is ranked in Table 3-82. The cottonwood trees are sparse, hence given a low rank. Willow, buttonbush, and red-osier dogwood are the most important shrubs. None of the herbaceous plants along the margin is especially important. Sword-grass and soft-stem bulrush are the dominant emergents; short-tailed rush and common cattail are important associates. Bullhead-lily is the most important aquatic species; waterlily is an important associate. Stonewort is very sparse in the lagoon, in contrast to the situation in all the ponds discussed above.

In the western portion of the West Unit known as Miller Woods there is between the Grand Calumet River and the Indiana Harbor Belt tracks a chain of intradunal ponds extending in an east-west direction. The organisms found in and around the easternmost large pond in this chain are listed and/or ranked in Table 3-83. The open water of this and the other ponds in the chain, as indicated by the E-1 coding on the land use map, is quite extensive. Stonewort is the dominant plant of the open water, but there are extensive patches of spatterdock and bullhead-lily as well. In the shallow water along the edges of the pond common cattail is dominant; this area is coded E-2 on the land use map. Along the margins there is a sparse growth of moist-soil shrubs, but a rather dense growth of herbaceous plants that thrive on such substrates. Northern reedgrass is the most important of these herbaceous plants; also present are several species not too commonly found in the national lakeshore: nodding ladies'-tresses, marsh bellflower, marsh skullcap, Leonard skullcap, and great lobelia.

Farther south in Miller Woods, between the Indiana Harbor Belt and the Baltimore and Ohio Tracks is the swell and swale topography described above. That is, there is a series of parallel ridges, the swells, some portions of which are higher than others, which extend east-northeast to west-southwest. Between the ridges are depressions, the swales. In most cases these swales are occupied by marshes, wetland communities regularly developed in the shallow water at the edge of filling ponds, which communities are typically the next stage in succession as ponds become filled in. These marshes will be described in the wetland section below. In some cases, however, there are sufficiently large amounts of open water within the marsh

Table 3-82. Ranks of vegetation in and around Grand Calumet River lagoon in West Unit--NE¼ NE¼ NW¼, section 31, T 37 N, R 7 W.

Populus deltoides cottonwood	4	Marginal Trees
Salix spp. willow shrubs	6	Shrubs
Cephalanthus occidentalis buttonbush	5	
Cornus stolonifera red-osier dogwood	5	
Hypericum kalmianum Kalm's St.-John's-wort	4	
Rosa palustris swamp rose	2	
Asclepias incarnata swamp milkweed	3	Herbs
Calamogrostis inexpansa brevior northern reedgrass	3	
Elymus canadensis nodding wild rye	3	
Eupatorium perfoliatum common boneset	3	
Pycnanthemum virginianum common mountain-mint	3	
Alisma triviale common water-plantain	2	
Lobelia kalmii Kalm lobelia	2	
Sabatia angularis rose-pink	2	
Triglochin maritima arrow-grass	2	
Scirpus americanus sword-grass	7	Emergent
Scirpus validus soft-stem bulrush	7	
Juncus brevicaudatus short-tailed rush	5	
Typha latifolia common cattail	5	
Pontederia cordata pickerelweed	4	
Eleocharis obtusa blunt spikerush	2	
Nuphar variegatum bullhead-lily	7	Aquatic
Nymphaea tuberosa waterlily	5	
Chara sp. stonewort	2	

Table 3-83A. Ranks of vegetation in and around intradunal pond of Miller Woods between Grand Calumet River and Indiana Harbor Belt tracks--center of SE¼ NW¼, section 31, T 37 N, R 7 W., West Unit.

Cornus stolonifera red-osier dogwood	3	Marginal Shrubs
Salix spp. willow shrubs	3	
Rosa palustris swamp rose	3	
Calamogrostis inexpansa brevior northern reedgrass	6	Herbs 27 July 78
Asclepias incarnata swamp milkweed	5	
Thelypteris palustris pubescens marsh fern	4	
Alisma subcordatum heart-shaped water-plantain	3	
Lythrum salicaria purple loosestrife	3	
Lythrum alatum wing-angled loosestrife	2	
Mimulus ringens monkey-flower	2	
Pycnanthemum virginianum common mountain-mint	2	
Solidago altissima tall goldenrod	5	15 Sept. 79
Aster umbellatus flat-topped white aster	4	
Eupatorium perfoliatum common boneset	4	
Coreopsis tripteris tall coreopsis	3	
Gerardia purpurea purple gerardia	3	
Solidago graminifolia grass-leaved goldenrod	3	
Gentiana crinita fringed gentian	2	
Lobelia siphilitica great lobelia	2	
Sabatia angularis rose-pink	2	
Spiranthes cernua nodding ladies'-tresses	2	

Table 3-83A continued

Campanula aparinoides marsh bellflower	1	
Scutellaria epilobiifolia marsh skullcap	1	
Scutellaria parvula leonardi Leonard skullcap	1	
Typha latifolia common cattail	7	Emergent
Scirpus validus soft-stem bulrush	5	
Scirpus americanus sword-grass	4	
Typha angustifolia narrowleaf cattail	4	
Chara sp. stonewort	8	Aquatic
Nuphar advena spatterdock	6	
Nuphar variegatum bullhead-lily	6	
Potamogeton sp. pondweed	5	
Numphaea tuberosa waterlily	4	
Polygonum sp. knotweed, smartweed	4 4	
Utricularia sp. bladderwort	3	

Table 3-83B. Counts of plankta in measured sample from intradunal pond of Miller Woods between Grand Calumet River and Indiana Harbor Belt tracks--center of SE¼ NW¼, section 31, T 37 N, R 7 W.

colonial green algae	
Pediastrum	1
filamentous green algae	
Oedogonium, Mougeotia, etc.	103
colonial blue-green algae	
Anabaena	9
Microcystis	1
diatoms	
Navicula, Synedra, Campylodiscus, etc.	24
protozoa	
Arcella	1
nauplius larvae	2
round worm	1

Total count in 0.25 ml sample: 142

25 quarts concentrated into 2 ounces

Calculated number of plankta per liter: 1420

Table 3-83C. Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of Miller Woods between Grand Calumet River and Indiana Harbor Belt tracks--center of SE¼ NW¼, section 31, T 37 N, R 7 W.

Odonata	
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	13
Aeschnidae (dragonflies), Anax sp. (nymph)	1
Libellulidae (dragonflies), nymph	1
Ephemeroptera (mayflies)	
Caenidae, Caenis sp. (nymphs)	4
Hemiptera	
Nepidae (water scorpions), Ranatra fusca	3
Belastomatidae (giant water bugs), nymph	1
Gerridae (water striders), Gerris buenoi	3
Notonectidae (back swimmers) nymph	1
Mesoveliidae (water treaders), Mesovelia mulsanti	2
Coleoptera	
Gyrinidae (whirligig beetles), Dineutes hornii	26
Dytiscidae (predaceous diving beetles), Hydroporus consimilis	7
Amphipoda	
Gammaridae (scuds), Gammarus sp.	21
Decapoda	
Astacidae (crayfish), Cambarus sp.	2
Mollusca	
Physidae (pouch snails), Physa sp.	1
Planorbidae (orb snails)	1
Lymnaeidae (pond snails)	1
Hirudinea (leeches)	1
Total:	89

Table 3-84A. Ranks of vegetation in and around intradunal pond of Miller Woods south of Indiana Harbor Belt tracks -- SE¼ NE¼ NW¼, section 1, T 36 N, R 8 W., West Unit.

Cornus sp. dogwood	2	Marginal Shrubs
Calamogrostis canadensis bluejoint	8	Herbs 20 Aug. 80
Eupatorium perfoliatum common boneset	4	
Ludwigia alternifolia seedbox	4	
Mimulus ringens moneky-flower	3	
Thelypteris palustris pubescens marsh fern	3	
Gerardia purpurea purple gerardia	2	
Pycnanthemum virginianum common mountain-mint	2	
Sabatia angularis rose-pink	2	
Scirpus cyperinus wool-grass	2	
Scirpus validus soft-stem bulrush	5	Emergent
Sagittaria latifolia common arrowhead	4	
Dulichium arundinaceum three-way sedge	3	
Ludwigia polycarpa false loosestrife	3	
Penthorum sedoides ditch stonecrop	3	
Ranunculus flabellaris yellow water-crowfoot	3	
Nuphar advena spatterdock	7	Aquatic
Nymphaea tuberosa waterlily	6	
Ceratophyllum demersum hornwort	5	
Polygonum sp. knotweed, smartweed	5	
Potamogeton sp. pondweed	4	

Table 3-84B. Counts of plankta in measured sample from intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SE¼ NE¼ NW¼, section 1, T 36 N, R 8 W., West Unit.

colonial green algae	
Pandorina	4
filamentous green algae	
Oedogonium	20
Ulothrix	3
others	5
colonial blue-green algae	
Merismopedia	5
filamentous blue-green algae	
Oscillatoria	13
Anabaena	8
unicellular desmids	4
diatoms	
Navicula, Synedra, etc.	26
cladocera	8
copepods	6
ostracods	3
nauplius larvae	10

Total count in 0.25 ml sample: 115

25 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 575

Table 3-84C. Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SE¼ NE¼ NW¼, section 1, T 36 N, R 8 W.

Odonata	
Aeschnidae (dragonflies), Anax sp. (nymphs)	6
Libellulidae (dragonflies), nymphs	8
Coenagrionidae (damselflies), Lestes sp. (nymph)	1
Hemiptera	
Notonectidae (backswimmers),	
Notonecta undulata	4
Buenoa sp. (nymphs)	6
Belostomatidae (giant water bugs), Belostoma fluminea	3
Mesoveliidae (water treaders), Mesovelia mulsanti	5
Gelastocoridae (toad bugs), Gelastocoris oculatus	1
Coleoptera	
Dytiscidae (predaceous diving beetles)	
Graphoderus liberus	7
Laccophilus maculosus	2
Hydroporus consimilis	1
Hydrophilidae (water scavenger beetles)	
Tropisternus glaber	1
larva	1
Amphipoda	
Gammaridae (scuds), Gammarus sp.	18
Decapoda	
Astacidae (crayfish), Cambarus sp.	10
Mollusca	
Physidae (pouch snails), Physa sp.	6
Lymnaeidae (pond snails), Lymnaea sp.	7
Planorbidae (orb snails)	9
Amphibia	
Ranidae (frogs), Rana sp. tadpoles	3
Salamandridae, Notophthalmus viridescens (newt)	2
Total:	101

vegetation that the community can be considered a pond in a very late stage of succession. And in a very few cases there are ponds surrounded by very little marsh. One such pond with very little marshy vegetation lies far to the west just south of the Indiana Harbor Belt tracks, at SE¼ NE¼ NW¼, section 1, T 36 N, R 8 W. The organisms found in and around this pond are listed and/or ranked in Table 3-84. Bluejoint grass is the dominant plant along the margin of this pond. Soft-stem bulrush is the dominant plant in the zone of emergent vegetation, but as SR 5 indicates it is not particularly dense; conspicuously absent are cattails. Spatterdock and waterlily are the dominant aquatic plants. The sparsity of woody vegetation along the margin of this pond and the low density of emergent vegetation and the absence of cattail in the zone of emergent vegetation all indicate that this pond does not fit into the sequence of succession that has been followed in our treatment of intradunal ponds thus far.

A pond that does fit into the successional sequence, one in a very late stage of succession and shown on the land use map as E-1 surrounded by E-2, is located farther to the east south of the Indiana Harbor Belt tracks, at SW¼ NE¼ NE¼, section 1, T 36 N, R 8 W. The plants found in and around this pond and the macroscopic animals of the littoral zone are listed and/or ranked in Table 3-85; we were, however, unable to get to the open water to collect a plankton sample in this case. Dominating the open water are spatterdock and bullhead-lily; a number of other species are relatively common. Surrounding the open water is a very extensive marsh dominated by cattails; soft-stem bulrush is an important associate.

In the two depressions lying immediately to the east of the pond described in the previous paragraph, and in a number of others, there are patches to the center where cattail and bulrush are not established. Characteristically present in these patches are spatterdock and bullhead-lily, and often in such abundance that the water in which they are growing is hardly visible. This situation, of course, represents a final stage in succession from pond to marsh.

When the counts of plankta from the two ponds in Miller Woods from which samples were taken are compared with one another and with those from the previously described intradunal ponds, the following is noted. The calculated number of organisms per liter is moderate. A variety of organisms contribute materially toward building up the numbers: the filamentous green alga Oedogonium, the filamentous blue-green alga Anabaena, and the diatoms.

When the counts of the macroscopic animals collected in the littoral zones of the three ponds in Miller Woods are compared with one another and with those from the previously described intradunal ponds, the following items are noted. The counts of the pond north of the Indiana Harbor Belt tracks and of the pond south of these tracks which lies to the west are rather high both in number of organisms and number of

Table 3-85A. Ranks of vegetation in and around intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SW¼ NE¼ NE¼, section 1, T 36 N, R 8 W.

Cephalanthus occidentalis buttonbush	3	Marginal Shrubs
Salix spp. willow shrubs	3	
Asclepias incarnata swamp milkweed	4	Herbs
Iris virginica shrevei wild iris	3	
Lythrum alatum wing-angled loosestrife	3	
Pycnanthemum virginianum common mountain-mint	3	
Lythrum salicaria purple loosestrife	2	
Typha angustifolia narrowleaf cattail	8	Emergent
Typha latifolia common cattail	8	
Scirpus validus soft-stem bulrush	6	
Nuphar advena spatterdock	7	Aquatic
Nuphar variegatum bullhead-lily	7	
Ceratophyllum demersum hornwort	5	
Nymphaea tuberosa waterlily	5	
Potamogeton sp. pondweed	5	
Brasenia schreberi watershield	4	
Polygonum sp. knotweed, smartweed	4	
Ranunculus flabellaris yellow water-crowfoot	4	
Utricularia sp. bladderwort	4	

Table 3-85B. Counts of macroscopic animals collected in half hour from littoral zone of intradunal pond of Miller Woods south of Indiana Harbor Belt tracks--SW¼ NE¼ NE¼, section 1, T 36 N, R 8 W.

Ephemeroptera (mayflies)	
Caenidae	4
Odonata	
Libellulidae (dragonflies), nymphs	9
Aeschnidae (dragonflies), nymph	1
Coenargrionidae (damselflies), nymph	1
Hemiptera	
Belostomatidae (giant water bugs), Belostoma fluminea	1
Gerridae (water striders), Gerris marginatus	1
Mesoviliidae (water treaders), Mesovelia mulsanti	1
Coleoptera	
Haliplidae (crawling water beetles), Haliplus immaculicollis	1
Hydrophilidae (water scavenger beetles)	
Berosus striatus	1
larva	1
Dytiscidae (predaceous diving beetles)	1
Decapoda	
Astacidae (crayfish), Cambarus sp.	2
Mollusca	
Physidae (pouch snails), Physa sp.	6
Planorbidae (orb snails)	5
Lymnaeidae (pond snails)	1
Pisces	
Umbridae (mudminnows), Umbra pygmaea	4
Total:	40

taxa (species, families, etc.). The number of organisms is not as large, however, as in the samples from some of the intradunal ponds east of United States Steel. The count in the pond south of the Indiana Harbor Belt tracks which lies to the east is considerably lower; it would be increased by about 50%, however, had we taken all the mudminnows we found rather than the few we needed for identification. These observations do not contradict the conclusion we have drawn from the vegetation of these and other intradunal ponds that the pond north of the Indiana Harbor Belt tracks and that south of the Indiana Harbor Belt tracks which lies to the east represent late stages of pond succession. Though numbers/biomass and diversity typically increase as succession proceeds, they apparently tend to stabilize and may actually decrease in later stages. In all three ponds there is a large amount of plant and animal detritus in the littoral zone. It is not surprising, therefore, that some of the most abundant macroscopic animals there are scavengers: scuds, pond snails, pouch snails, and crayfish. In the pond north of the Indiana Harbor Belt tracks the other abundant animals are whirligig beetles and damselfly nymphs.

West Unit interdunal pond -- An interdunal pond called Long Lake lies in Porter county at the Lake county line within the marshy basin betweenthe Tolleston and Algonquin beach ridges and more recent dunes to the north. The roadbed of the now abandoned Indiana Harbor Belt rail line forms the northern margin of the lake. Our study was concentrated along this margin, but because there is a rather steep slope into the water here we were not able to move very far into the lake in our waders. The organisms observed and collected in Long Lake are listed and/or ranked in Table 3-86.

The dominant plants along the wet margins of Long Lake are shrubs: buttonbush, willows, and hardhack. The dominant plant of the zone of emergent vegetation is common cattail; a number of additional species are present, but none with a SR greater than 3. Waterweed, spatterdock, and large-leaved pondweed are the dominant aquatic plants. The plankton count of Long Lake is moderately high, with a predominance of filamentous green and blue-green algae. But very few macroscopic animals were taken in the half hour of collecting; that there should be so few organisms of this sort, which serve as food for fish, is a surprising observation in view of the number of persons who fish in Long Lake apparently with some success.

Cowles Unit interdunal ponds -- There are a number of ponds in the Cowles Unit between Mineral Springs Road on the east and the Northern Indiana Public Service Company property line on the west. Most, if not all, of them appear to be a part of the long marshy area described above which lies between the Calumet beach ridge and the recent dunes, hence to be interdunal. The topographic map shows a series of crescent-shaped dunes extending from the foredunes and high dunes immediately behind them on the north toward the marshy area on the south; the concave part of the crescent is to the west. The southern margin of the marshy area is at the 610 foot contour line. Depressions between the crescent-shaped dunes at this elevation contain extensions or pockets of this marsh (pockets appear rather than extensions when the western tip of one crescent continues as far westward as the next crescent).

Table 3-86A. Ranks of vegetation in and around Long Lake--center of section 34, T 37 N, R 7 W., West Unit.

Cephalanthus occidentalis buttonbush	6	Emergent Shrubs
Salix spp. willow shrubs	5	
Spiraea tomentosa hardhack	4	
Typha latifolia common cattail	8	Herbs
Iris virginica shrevei wild iris	3	
Juncus brevicaudatus short-tailed rush	3	
Lythrum alatum wing-angled loosestrife	3	
Sagittaria latifolia common arrowhead	3	
Alisma triviale common water-plantain	2	
Carex scoparia broom-like sedge	2	
Scirpus americanus sword-grass	2	
Scirpus validus soft-stem bulrush	2	
Elodea canadensis waterweed	8	Aquatic
Nuphar advena spatterdock	7	
Potamogeton amplifolius large-leaved pondweed	6	
Ceratophyllum demersum hornwort	5	
Najas flexilis naiad	5	
Nymphaea tuberosa waterlily	5	
Potamogeton gramineus variable pondweed	4	
Potamogeton natans floating-leaf pondweed	4	
Sagittaria graminea grass-leaved arrowhead	3	
Utricularia vulgaris greater bladderwort	3	
Lemna trisulca submerged duckweed	2	
Potamogeton sp. pondweed	2	

Table 3-86B. Counts of plankta in measured sample from Long Lake--center of section 34, T 37 N, R 7 W.

colonial green algae	
Uroglenopsis	9
filamentous green algae	
Oedogonium, Spirogyra, etc.	52
dinoflagellates	5
colonial blue-green algae	2
filamentous blue-green algae	19
unicellular desmids	1
diatoms	
Fragillaria	12
protozoa	
Arcella	1
rotifers	4
cladocera	1
copepods	2
ostracods	2
nauplius larvae	2

Total count in 0.25 ml sample: 112

20 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 700

Table 3-86C. Counts of macroscopic animals collected in half hour from littoral zone of Long Lake--center of section 34, T 37 N, R 7 W., West Unit.

Odonata	
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	3
Hemiptera	
Gerridae (water striders), Gerris marginatus	3
Amphipoda	
Gammaridae (scuds), Gammarus sp.	4
Mollusca	
Planorbidae (orb snails)	4
Total:	14

As has been pointed out before it is impossible to make a sharp distinction between ponds and wetlands. This is particularly obvious in this area. The large area which the topographic maps shows as marsh which extends to the northeast, at NW¼ SE¼ NE¼, section 22, T 37 N, R 6 W, contained little open water in mid-summer of 1974 and is considered in this chapter to be marsh; its two parts are coded E-2 on the land use map. Three large pockets at the same (610 foot contour appear southwest of this extension at SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W; at NE¼ NE¼ SW¼, section 22, T 37 N, R 6 W; and at center of W margin of SW¼, section 22, T 37 N, R 6 W. Though all these are also coded E-2 (marsh) on the land use map, the first and third pockets listed contained sufficient open water in mid-summer of 1974 to be considered ponds in this chapter. In our discussion which follows we will refer to the pond at the center of the W margin of SW¼, section 22, T 37 N, R 6 W, as pond #7, the number assigned it in Sargent and Lundy Engineering Drawing No. MS-172 of Job No. 4097; we will refer to the pond at SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W, as pond #19, a number not used on the Sargent and Lundy drawing. The organisms observed and collected in these two ponds are ranked and/or listed in Tables 3-87 and 3-88.

Just west of pond #7 there is a rather high dune ridge which extends in a north-south direction. Between this ridge and the NIPSCO property line on the west and south are several additional ponds. The land use map shows five of them greater than half an acre in size. The Sargent and Lundy drawing numbers them 1 to 5 as follows. #1 is at SW¼ NE¼ SW¼, section 21, T 37 N, R 6 W. #2 is at S½ NW¼ SE¼, section 21, T 37 N, R 6 W. # 3 is at center of E½ NE¼ SW¼, section 21, T 37 N, R 6 W. #4 is at center of S margin of SW¼ SW¼ NE¼, section 21, T 37 N, R 6 W. #5 is at N½ NE¼ NE¼SW¼, section 21, T 37 N, R 6 W. When the Dune Acres topographic map is examined it is seen that these ponds, just as those to the east of the ridge, occupy pockets within the 610 foot contour line. The elevations between ponds #1, #2, and #3 are so small that they are regularly interconnected; indeed the topographic map with 2 foot contour intervals shows them as a single pond with a water level of 609.3'. On this same topographic map ponds #4 and #5 are shown to have water levels of 603.1' and 603.0' respectively. But 614 foot contour lines extend between ponds # 4 and #5 or of either of these with pond #3 or those regularly interconnected with it. The organisms observed and collected in pond #5 are ranked and/or listed in Table 3-89. Ponds #1, #2, and #3 are now bounded immediately to the south by a road on NIPSCO property beyond which lie this company's settling ponds and Bethlehem Steel Corporation buildings. Examination of the 1953 Dune Acres topographic map and of 1938 and 1958 aerial photographs of the area shows that prior to the construction of the Bailly generating station and the Bethlehem Steel plant there were several additional marshy areas to the south and west within the 610 foot contour. The 1938 and 1958 aerial photographs show that the only depression of these three holding open water in the fall of the year when these photographs were taken was that in which pond #2 is located. The fact that there is considerable open water

Table 3-87A. Ranks of vegetation in and around pond #19 in Cowles Unit--SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W.

Cephalanthus occidentalis buttonbush	6	Emergent Shrubs
Spiraea alba meadow-sweet	5	
Spiraea tomentosa hardhack	3	
Typha latifolia common cattail	6	Herbs
Dulichium arundinaceum three-way sedge	5	
Sagittaria latifolia common arrowhead	5	
Scirpus acutus hard-stem bulrush	5	
Calamogrostis inexpansa brevior northern reedgrass	4	
Eleocharis melanocarpa black-fruited spikerush	3	
Lysimachia terrestris yellow loosestrife	3	
Nuphar advena spatterdock	7	Aquatic
Polygonum amphibium stipulaceum water smartweed	6	
Utricularia purpurea purple bladderwort	5	
Myriphyllum sp. water-milfoil	2	

Table 3-87B. Counts of plankta in measured sample from #19 in Cowles Unit--SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W.

fliamentous green algae	
Spirogyra, etc.	23
dinoflagellates	4
filamentous blue-green algae	
Oscillatoria	6
colonial blue-green algae	2
unicellular desmids	
Microasterias	2
others	18
filamentous desmids	
Genicularia	500*
Gymnozyga	28
protozoa	
Difflugia	1
cladocera	1

Total count in 0.25 ml sample: 588

20 quarts concentrated into 2 ounces

Calculated number of plankta per liter: 7350

*Because of the difficulty in counting when filaments are broken and partially broken, this figure is an estimate only.

Table 3-87C. Counts of macroscopic animals collected in half hour from littoral zone of pond #19 in Cowles Unit--SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W.

Ephemeroptera (mayflies)	
Baetidae, numph	1
Odonata	
Libellulidae (dragonflies), nymphs	2
Aeschnidae (dragonflies), nymphs	2
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	9
Hemiptera	
Corixidae (water boatmen)	11
Notonectidae (backswimmers), Notonecta undulata	1
Coleoptera	
Gyrinidae (whirligig beetles)	
Dineutes assimilis	6
Gyrinus sp.	6
Dytiscidae (predaceous diving beetles), larvae	3
Chrysomelidae (leaf beetles), Galerucella sp.	6
Diptera	
Chironomidae (midges), larvae	14
Chaoboridae (phantom midges), Chaoborus sp. (larvae)	2
Isopoda	
Asellidae (sow bugs)	1
Hydracarina (water mites)	2
Mollusca	
Sphaeriidae (fingernail clams), Pisidium sp.	50+
Lymnaeidae (pond snails), Lymnaea sp.	3
Total:	119

Table 3-88A. Ranks of vegetation in and around pond #7 in Cowles Unit--center of W margin of SW¼, section 22, T 37 N, R 6 W.

Aronia melanocarpa black chokeberry	6	Emergent Shrubs
Cephalanthus occidentalis buttonbush	6	
Spiraea tomentosa hardhack	4	
Calamogrostis inexpansa brevior northern reedgrass	5	Herbs
Juncus brevicaudatus short-tailed rush	5	
Typha latifolia common cattail	4	
Carex comosa bristly sedge	3	
Myriophyllum heterophyllum diverse-leaved water-milfoil	7	Aquatic
Dulichium arundinaceum three-way sedge	6	
Nuphar advena spatterdock	6	
Utricularia purpurea purple bladderwort	6	
Pontederia cordata pickerelweed	4	
Brasenia schreberi watershield	3	
Sagittaria graminea grass-leaved arrowhead	2	

Table 3-88B. Counts of plankta in measured sample from pond #7 in Cowles Unit--center of W margin of SW¼, section 22, T 37 N, R 6 W.

colonial green algae	
Pediastrum	4
dinoflagellates	50
unicellular desmids	
Microasterias	2
others	74
filamentous desmids	
Spondylosium, Aptogonium, etc.	22
filamentous blue-green algae	2
diatoms	
Pinnularia, etc.	22
rotifers	1

Total count in 0.25 ml sample: 177

20 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 1106

Table 3-88C. Counts of macroscopic animals collected in half hour from littoral zone of pond #7 in Cowles Unit--center of W margin of SW¼, section 22, T 37 N, R 6 W.

Odonata	
Libellulidae (dragonflies), nymph	1
Hemiptera	
Corixidae (water boatmen)	2
Notonectidae (backswimmers), Notonecta undulata	2
Pleidae (pigmy backswimmers), Plea striola	1
Gerridae (water striders), Gerris marginatus	1
Diptera	
Chironomidae (midges), larva	1
Mollusca	
Sphaeriidae (fingernail clams), Pisidium sp.	11
Physidae (pouch snails), Physa sp.	1
Planorbidae (orb snails)	1
Lymnaeidae (pond snails), Lymnaea sp.	4
Total:	25

Table 3-89A. Ranks of vegetation in and around pond #5 in Cowles Unit-- NE¼ NE¼ SW¼, section 21, T 37 N, R 6 W.

Cephalanthus occidentalis buttonbush	5	Emergent Shrubs
Typha latifolia common cattail	5	Herbs
Polygonum coccineum swamp smartweed	3	
Typha angustifolia narrowleaf cattail	3	
Chara vulgaris stonewort	8	Aquatic
Utricularia vulgaris greater bladderwort	6	
Lemna minor lesser duckweed	5	
Lemna trisulca submerged duckweed	4	
Brasenia schreberi watershield	3	
Polygonum amphibium stipulaceum water smartweed	3	
Sagittaria graminea grass-leaved arrowhead	2	

Table 3-89B. Counts of plankta in measured sample from pond #5 in Cowles Unit-- NE¼ NE¼ SW¼, section 21, T 37 N, R 6 W.

unicellular green algae	
Ankistrodesmus	2
colonial green algae	
Volvox	2
others	1
dinoflagellates	1
unicellular desmids	8
diatoms	
Navicula, Amphora, Tabellaria, etc.	56
protozoa	
Arcella	1
rotifers	3
ostracods	2

Total count in 0.25 ml sample: 76

20 quarts concentrated into 1 ounce

Calculated number of plankta per liter: 475

Table 3-89C. Counts of macroscopic animals collected in half hour from littoral zone of pond #5 in Cowles Unit--NE¼ NE¼ SW¼, section 21, T 37 N, R 6 W.

Odonata	
Libellulidae (dragonflies), nymph	1
Coenagrionidae (damselflies), Ischnura sp. (nymphs)	14
Hemiptera	
Corixidae (water boatmen)	3
Notonectidae (backswimmers), Notonecta undulata	8
Gerridae (water striders), Gerris marginatus	1
Mesoveliidae (water treaders), Mesovelia mulsanti	1
Coleoptera	
Heliplidae (crawling water beetles), Haliplus sp.	11
Amphipoda	
Gammaridae (scuds), Gammarus sp.	35
Hydracarina (water mites)	2
Hirudinea (leeches)	1
Mollusca	
Sphaeriidae (fingernail clams), Pisidium sp.	5
Planorbidae (orb snails)	5
Lymnaeidae (pond snails), Lymnaea sp.	3
Total:	90

present in all depressions throughout the year at present indicates a rise in water level in this area since the construction of the Bethlehem Steel Corporation Burns Harbor plant and the Bailly generating station in the early 1960's. The organisms observed and collected in pond #2 and in ponds #1 and #3 are ranked and/or listed in Tables 3-90 and 3-91.

There are some interesting differences among these several Cowles Unit interdunal ponds, and between them as a group and the intradunal ponds of the West Unit. These interdunal ponds are on older substrates and in the midst of older communities, and may themselves have existed for a longer period of time than the intradunal ponds. There is not the broad transitional zone of marginal vegetation characteristic of the intradunal ponds, therefore we no longer include a list of ranking of marginal vegetation. Cattails are among the important emergent herbaceous plants in all these interdunal ponds, as they are in the intradunal ponds in later stages of succession. Encircling these interdunal ponds, in addition to the cattails, is the woody buttonbush, a species found at the margin of only the most mature of the intradunal ponds and there typically with a somewhat lower stratum rank. The greatest variety of emergent plants is in pond #19, the least in pond #5. Spatterdock is an important component in the aquatic category of all but pond #5. In pond #5 stonewort and greater bladderwort are important aquatic components. Naiad is the most important aquatic plant in pond #2 and has some importance (SR 3) in ponds #1 and #3, but was not recorded from the other ponds. It should be noted, though this appears nowhere in the tables, that there are many trunks of dead trees and shrubs in the shallow water along the margins of ponds #1, #2, and #3; this conforms with the point made in the previous paragraph that the water level in these ponds is higher now than it was prior to the 1960's.

Ponds #5 and #7 contain a moderate number of plankta per liter. Diatoms make up the larger part of the count in pond #5. In this respect, and in the importance of stonewort in the aquatic zone, pond #5 is similar to the intradunal ponds in the West Unit west of Ogden Dunes which are rather early in succession; pond #5 is unlike them, however, in that cattails and buttonbush are important in the zone of emergent vegetation. In pond #7 desmids are by far the most abundant plankta, followed by dinoflagellates and diatoms. Pond #19 has a high count of plankta per liter, with the filamentous desmid Genicularia constituting over 80% of the count. Ponds #1 and #3 and pond #2 have even higher plankta counts that #19; the only higher count in our study is that in the intradunal pond east of the United States Steel slag pile. The organisms contributing most heavily to the counts in these ponds, particularly in pond #2, is the colonial green alga Uroglenopsis. This species is listed by Standard Methods (1971) among the taste and odor algae and is said by Prescott (1970, p. 238) to frequent "water that is contaminated with nitrogenous wastes." The large number of Uroglenopsis in these ponds may therefore be considered evidence of contamination.

Table 3-90A. Ranks of vegetation in and around pond #2 in Cowles Unit--center of W½ SE¼, section 21, T 37 N, R 6 W.

Cephalanthus occidentalis buttonbush	4	Emergent Shrubs
Typha latifolia common cattail	8	Herbs
Juncus balticus littoralis lakeshore rush	5	
Sagittaria graminea grass-leaved arrowhead	5	
Decodon verticillatus swamp loosestrife	3	
Pontederia cordata pickerelweed	2	
Najas flexilis naiad	8	Aquatic
Nuphar advena spatterdock	6	
Nymphaea tuberosa waterlily	4	
Chara vulgaris stonewort	2	

Table 3-90B. Counts of plankta in measured sample from pond #2 in Cowles Unit--center of W½ SE¼, section 21, T 37 N, R 6 W.

colonial green algae	
Uroglenopsis	189
filamentous green algae	
Oedogonium, etc.	7
dinoflagellates	1
colonial blue-green algae	4
diatoms	3
cladocera	6
rotifers	2

Total count in 0.25 ml sample: 212

20 quarts concentrated into 8 ounces

Calculated number of plankta per liter: 10,600

Table 3-90C. Counts of macroscopic animals collected in half hour from littoral zone of pond #2 in Cowles Unit--center of W½ SE¼, section 21, T 37 N, R 6 W.

Odonata	
Libellulidae (dragonflies), nymphs	3
Coenagrionidae (damselflies), nymph	1
Hemiptera	
Gerridae (water striders), Gerris marginatus	3
Mesoveliidae (water treaders), Mesovelia mulsanti	3
Coleoptera	
Heliplidae (crawling water beetles), Haliplus sp.	1
Amphipoda	
Gammaridae (scuds), Gammarus sp.	2
Mollusca	
Physidae (pouch snails), Physa sp.	1
Planorbidae (orb snails)	
Total:	15

Table 3-91A. Ranks of vegetation in and around ponds #1 and #3 in Cowles Unit--SW¼ NW¼ SW¼, section 21, T 37 N, R 6 W.

Cephalanthus occidentalis buttonbush	3	Emergent Shrubs
Typha latifolia common cattail	7	Herbs
Decodon verticillatus swamp loosestrife	5	
Juncus balticus littoralis lakeshore rush	4	
Nuphar advena spatterdock	6	Aquatic
Sagittaria graminea grass-leaved arrowhead	4	
Utricularia vulgaris greater bladderwort	4	
Najas flexilis naiad	3	
Nymphaea tuberosa waterlily	3	
Potamogeton natans floating-leafe pondweed	3	

Table 3-91B. Counts of plankta in measured sample from ponds #1 and #3 in Cowles Unit--SW¼ NW¼ SW¼, section 21, T 37 N, R 6 W.

colonial green algae	
Uroglenopsis	87
Pediastrum	18
Selenastrum	11
filamentous green algae	2
dinoflagellates	38
colonial blue-green algae	4
unicellular desmids	3
diatoms	4
rotifers	4
copepods	1
nauplius larvae	1

Total count in 0.25 ml sample: 173

20 quarts concentrated into 8 ounces

Calculated number of plankta per liter: 8650

Table 3-91C. Counts of macroscopic animals collected in half hour from littoral zone of ponds #1 and #3 in Cowles Unit--SW¼ NW¼ SW¼, section 21, T 37 N, R 6 W.

Odonata	
Coenagrionidae (damselflies), nymphs	2
Hemiptera	
Gerridae (water striders), Gerris marginatus	2
Total:	4

The pond yielding the greatest number and variety of macroscopic animals per unit effort is #19. As a matter of fact, many more fingernail clams could have been collected than were, and if this is taken into account the only other pond in our study with a greater abundance of macroscopic animals is the intradunal pond north of the Grand Calumet River. The next greatest yield in number and variety from these interdunal ponds is from pond #5. Both pond #19 and pond #5 show little evidence of human disturbance. Pond #7 is relatively poor in number and variety of organisms; this pond has been dredged and has had its outlet dammed, but this was several decades ago and thus does not appear to account for the paucity of macroscopic animals here. Pond #2 and ponds #1 and #3 have the smallest yield per unit effort, though if anything more effort was spent in ponds #1 and #3 than in the others in hopes of finding something of interest. The contamination indicated by the presence of numerous Uroglenopsis in these ponds is quite likely a factor inhibiting rather than supporting the growth of macroscopic animals.

Morainal pond -- The final pond to be considered is developed on glacial till of the Valparaiso Moraine. It lies in a shallow basin immediately west of, and across Wozniak Road from, Pinhook Bog. As the land use map indicates, there is only a small patch of open water here surrounded by swamp. The plants found in and around this pond and the macroscopic animals found in its littoral zone are listed and/or ranked in Table 3-92; in this case, however, we were unable to get to the open water to collect a plankton sample. The dominant tree of the swamp surrounding the pond is red maple and the dominant shrub here is button bush. None of the herbaceous species along the margin has a high rank. Two plants listed here, however, are of interest: water arum, because of its rarity in this region; and false mermaid, because this is the only community in the national lakeshore in which we found it. Common arrowhead and common cattail are the dominant emergent plants. Spatterdock is the dominant plant of the open water. There is a rather large number of macroscopic animals, both with respect to number of organisms and number of taxa, in the littoral zone of this pond. Especially numerous are the beetles: crawling water beetles, water scavenger beetles, and predaceous diving beetles.

Little Calumet River -- We took plankton samples and collected macroscopic animals along the shoreline and from objects on the bottom of the Little Calumet River in two locations. One is near the head of the east branch in the Blue Heron Rookery Unit, at NW¼ NW¼ SE¼, section 27, T 37 N, R 5 W. The other is downstream in the Bailly Unit about a third of a mile east of Indiana 149, at SE¼ NE¼ NW¼, section 33, T 37 N, R 6 W. The vegetation of the galley forest adjacent to the former is described in the terrestrial community section above; the vegetation of the floodplain adjacent to the latter is described in the wetland community section below. The counts of the macroscopic animals taken at these two locations are given in Tables 3-93 and 3-94. When the plankton samples from these locations were examined on counting cells under the microscope numerous particles of detritus were observed, but no plankta were found. This

Table 3-92A. Ranks of vegetation in and around pond west of Pinhook Bog--SE¼ SW¼ NW¼, section 35, T 37 N, R 4 W.

Acer rubrum red maple	8	Marginal Trees
Larix laricina tamarack	4	
Salix sp. willow	4	
Nyssa sylvatica blackgum	3	
Cephalanthus occidentalis buttonbush	8	Shrubs
Rosa palustris swamp rose	5	
Aronia melanocarpa black chokeberry	3	
Sambucus canadensis common elder	3	
Rhus vernix poison sumac	2	
Carex crinita fringed sedge	4	Herbs
Calamogrostis canadensis bluejoint	3	
Calla palustris water arum	3	
Alisma sp. water-plantain	2	
Carex glaucodea gray-green sedge	2	
Equisetum arvense field horsetail	2	
Floerkea proserpinacoides false mermaid	2	
Sagittaria latifolia common arrowhead	6	Emergent Herbs
Typha latifolia common cattail	5	
Sparganium americanum American bur-reed	3	
Nuphar advena spatterdock	6	Aquatic
Lemna minor lesser duckweed	3	
Polygonum sp. knotweed, smartweed	3	

Table 3-92B. Counts of macroscopic animals collected in half hour from littoral zone of pond west of Pinhook Bog--SE¼ SW¼ NW¼, section 35, T 37 N, R 4 W.

Odonata	
Libellulidae (dragonflies), nymph	1
Coenagrionidae (damselflies), nymph	1
Hemiptera	
Notonectidae (backswimmers), nymph	1
Corixidae (water boatmen),	
Arctocorixa interrupta	3
A. alternata	2
Belostomatidae (giant water bugs), Belostoma fluminea	5
Gerridae (water striders), Gerris buenoi	1
Mesoveliidae (water treaders), Mesovelia mulsanti	13
Coleoptera	
Haliplidae (crawling water beetles), Haliplus immaculicollis	31
Dytiscidae (predaceous diving beetles)	
Hydroporus consimilis	5
H. undulatus	4
H. modestus	1
Coptotomus interrogatus	1
Laccophilus maculosus	1
Hydrophilidae (water scavenger beetles)	
Tropisternus glaber	15
T. nimbatus	1
Hydrochara obtusata	1
larva	1
Elmidae (riffle beetles)	4
Chrysomelidae (leaf beetles), Donacia cincticornis	1
Mollusca	
Sphaeriidae (fingernail clams)	16
Planorbidae (orb snails)	1
Anura	
Ranidae (frogs), Rana sp. tadpoles	2
Total:	112

Table 3-93. Counts of macroscopic animals collected in half hour along shoreline and from objects on the bottom of the Little Calumet River in the Blue Heron Rookery Unit--NW¼ NW¼ SE¼, section 27, T 37 N, R 5 W.

Odonata	
Agrionidae (damselflies), Agrion sp. (nymph)	2
Hemiptera	
Corixidae (water boatmen)	1
Veliidae (smaller water striders), Microvelia americana	3
Coleoptera	
Heliplidae (crawling water beetles), nymph	1
Amphipoda	
Gammaridae (scuds), Gammarus sp.	19
Decapoda	
Astacidae (crayfish), Cambarus sp.	1
Mollusca	
Physidae (pouch snails), Physa sp.	1
Total:	28

Table 3-94. Counts of macroscopic animals collected in half hour along shoreline and from objects on the bootom of the Little Calumet River in the Bailly Unit--SE¼ NE¼ NW¼, section 33, T 37 N, R 6 W.

Odonata	
Agrionidae (damselflies), Agrion sp. (nymph)	1
Hemiptera	
Corixidae (water boatmen)	2
Nepidae (water scorpions), Ranatra fusca	2
Belostomatidae (giant water bugs), Belostoma fluminea	1
Gerridae (water striders), Gerris remigis	1
Veliidae (smaller water striders), Microvelia sp.	1
Naucoridae (creeping water bugs), Pelocoris femoratus	1
Coleoptera	
Dytiscidae (predaceous diving beetles)	
Laccophilus maculosus	3
Hydroporus consimilis	2
Isopoda	
Asellidae (sow bugs), Asellus sp.	14
Amphipoda	
Gammaridae (scuds), Gammarus sp.	18
Decapoda	
Astacidae (crayfish), Cambarus sp.	1
Total:	47

is what is expected in a flowing stream. Scuds are the most abundant macroscopic animals of the Little Calumet, both near the head and farther downstream. Relatively few additional individuals and taxa are found near the head. Many more additional individuals and taxa are found farther downstream; especially abundant are the sow bugs and the families of true bugs. This pattern of greater numbers and diversity in older (downstream) portions of a stream than in its younger (upstream) portions is also what is expected. Contributing also the paucity of organisms in the Blue Heron Rookery portion is the fact that the channel here has been dredged.

Wetland Communities

There are several kinds of communities that are not properly considered either terrestrial or aquatic, for they have characteristics of each. These are the wetland communities. It is not always possible, however, to draw a sharp line of distinction between a wetland community and a related terrestrial or aquatic one. Thus the community groupings in this chapter are to a certain extend arbitrary and arranged for convenience. Three kinds of wetland community are represented in the Indiana Dunes National Lakeshore: marshes, swamps, and bogs.

Marshes are communities in which the dominant plants growing in a wet substrate are herbaceous species such as cattails, reeds, rushes, sedges, and grasses. Woody plants such as buttonbush, chokeberry, aspen, and willows may also be present; in time these species and other trees become dominant, but until they do the community is considered a marsh. As indicated in the previous section, because there are variations in water level from year to year and from season to season, a marsh cannot be sharply distinguished from a pond. Depressions containing open water in mid-summer of 1974, 1979, and 1980 were considered ponds for purposes of this study; those lacking open water at this time were considered marshes.

Swamps and communities in which the dominant plants growing in a wet substrate are trees. As indicated above there is not a clear line of distinction between marshes and swamps, and swamps in many cases succeed marshes.

A third type of wetland, often referred to as bogs, is that in which the substrate on which the vegetation grows consists almost entirely of peat; for that reason, this third type of wetland is also referred to as peatland. Peat is organic material representing the incomplete breakdown of plant materials by physical, chemical, and microbial action. Just as there is no sharp line of distinction between marshes and swamps, there is intergradation of peatlands with both marshes and swamps.

Marshes -- Regular reference was made in the terrestrial section above to marshy areas within those communities. As a matter of fact, some relatively small marshes were described as a matter of convenience in the context of terrestrial community with which they are associated. In this section are described some of the larger marshes of the national lakeshore.

The southwestern portion of the West Unit lying between the Indiana Harbor Belt and Baltimore and Ohio tracks is characterized by swell and swale topography. The type of community found on the ridges was described in the terrestrial section. In the depressions between the ridges, the swales, are numerous marshes and several ponds. The ponds were described in the aquatic section above. To be described here are the marshes. In Table 3-95 is ranked the vegetation of the largest of these marshes, that between the Amtrak and Baltimore and Ohio tracks which extends almost the entire width of this portion of the national lakeshore. Common and narrowleaf cattail are clearly the dominant plants; in some portions there is virtually nothing else present. Buttonbush is an important shrub along the edges. Where cattail is not so dense as to exclude other species soft-stem bulrush is an important herb. Spatterdock and pickerelweed are found in the small pockets of water scattered through the marsh. The small marshes so common in this portion of the national lakeshore have essentially the same composition as this large one.

A relatively small, but interesting, marsh lies just north of the Baltimore and Ohio tracks in the Tolleston-Algonquin dune complex south of U.S. 12 and west of County Line Road. Its vegetation is ranked in Table 3-96. The most important plants in this community are quaking aspen (SR 7) that have not reached tree size; cottonwoods of tree size are present, but of lesser importance (SR 6) and not providing a canopy of sufficient coverage that this would be considered a swamp. This is a community in transition from marsh to swamp, a shrub wetland; it is coded F-3 (shrubs and trees) on the land use map since there is no special designation for this type of wetland community. As in most of the marshes which follow, common cattail is among the most important herbs; bluejoint and common reed share dominance with it, and purple loosestrife is an important associate which adds considerable color to the community in the summer.

More than a dozen patches of marsh are identified as E-2 on the land use map in that portion of the West Unit which lies south of U.S. 12 and east of County Line Road. The vegetation of several of the largest of these patches was ranked. The vegetation of the marsh at the center of the northern half of SW¼ SW¼, section 34, T 37 N, R 7 W, is ranked in Table 3-97. Buttonbush is the most important woody plant in this community; it is particularly dense along the edges, especially toward the east. Purple loosestrife and narrow-leaf cattail are the dominant herbs. The loosestrife is particularly dense to the northwest portion of the marsh and forms a very colorful and striking mass there in the summer; the cattail is particularly dense in the southeastern portion of the marsh.

Table 3-95. Stratum ranks of vegetation of marsh in southwest portion of West Unit--SE¼ SE¼ NW¼, section 1, T 36 N, R 8 W.

Cephalanthus occidentalis buttonbush	5	Shrubs
Typha latifolia common cattail	7	Herbs
Typha angustifolia narrowleaf cattail	7	
Scirpus validus soft-stem bulrush	5	
Phragmites communis berlandieri common reed	4	
Calamogrostis inexpansa brevior northern reedgrass	4	
Nuphar advena spatterdock	3	
Osmunda cinnamomea cinnamon fern	3	
Osmunda regalis spectabilis royal fern	3	
Pontederia cordata pickerelweed	3	
Thelypteris palustris pubescens marsh fern	3	

Table 3-96. Stratum ranks of vegetation of small marsh in West Unit south of U.S. 12 and west of County Line Road--NE¼ NW¼ SE¼, section 5, T 36 N, R 7 W.

Populus deltoides cottonwood	6	Trees
Salix sp. willow	4	
Populus tremuloides quaking aspen	7	Shrubs
Cephalanthus occidentalis buttonbush	4	
Spiraea tomentosa hardhack	3	
Nyssa sylvatica blackgum	2	
Calamogrostis canadensis bluejoint	6	Herbs 21 May 79
Phragmites communis berlandieri common reed	6	
Typha latifolia common cattail	6	
Lythrum salicaria purple loosestrife	5	
Iris virginica shrevei wild iris	3	
Hypoxis hirsuta stargrass	2	
Oenothera biennis evening-primrose	2	
Eupatorium perfoliatum common boneset	5	14 Sept. 79
Solidago altissima tall goldenrod	4	
Solidago gymnospermoides lance-leaved goldenrod	4	
Gerardia purpurea purple gerardia	3	
Lycopus virginicus Virginia bugle-weed	3	
Scirpus cyperinus wool-grass	2	

Table 3-97. Stratum ranks of vegetation of marsh in West Unit south of U.S. 12 and east of County Line Road--center of N½ SW¼ SW¼, section 34, T 37 N, R 7 W.

Cephalanthus occidentalis buttonbush	7	Shrubs
Populus deltoides cottonwood	3	
Populus tremuloides quaking apsen	3	
Rhus typhina staghorn sumac	3	
Rhus copallina shining sumac	3	
Salix spp. willow shrubs	2	
Heuchera hirsuticaulis tall alumroot	2	Herbs 28 May 79 6 July 78
Lythrum salicaria purple loosestrife	7	
Typha angustifolia narrowleaf cattail	7	
Thelypteris palustris pubescens marsh fern	3	
Phragmites communis berlandieri common reed	3	
Aster umbellatus flat-topped white aster	4	14 Sept. 79
Bidens coronata crowned tickseed-sunflower	4	
Helianthus giganteus giant sunflower	4	
Solidago patula rough-leaved goldenrod	4	
Coreopsis tripteris tall coreopsis	3	
Eupatorium maculatum spotted Joe-Pye-weed	3	
Gerardia purpurea purple gerardia	3	
Scirpus cyperinus wool-grass	3	
Eupatorium perfoliatum common boneset	2	
Solidago graminifolia grass-leaved goldenrod	2	

Table 3-98. Stratum ranks of vegetation of marsh in West Unit south of U.S. 12 and east of County Line Road--¼ mile E of SW corner, section 34, T 37 N, R 7 W.

Rhus copallina shining sumac	6	Shrubs
Cephalanthus occidentalis buttonbush	6	
Spiraea tomentosa hardhack	4	
Populus tremuloides quaking apsen	3	
Salix spp. willow shrubs	3	
Rosa palustris swamp rose	3	
Typha angustifolia narrowleaf cattail	6	Herbs
Typha latifolia common cattail	6	
Lythrum salicaria purple loosestrife	6	
Calamogrostis inexpansa brevior northern reedgrass	5	
Scirpus validus soft-stem bulrush	4	
Eupatorium perfoliatum common boneset	3	
Aster umbellatus flat-topped white aster	4	
Solidago patula rough-leaved goldenrod	4	
Bidens coronata corwned tickseed-sunflower	3	
Eupatorium maculatum spotted Joe-Pye-weed	3	
Helianthus giganteus giant sunflower	3	

The vegetation of the marsh centered ¼ mile east of the SW corner of section 34, T 37 N, R 7 W, is ranked in Table 3-98. Buttonbush and shining sumac, concentrated along the edges, are the most important shrubs. Purple loosestrife and common and narrowleaf cattail share dominance among the herbs. The other three marshes in the western third of this portion of the West Unit are essentially like this one in composition.

The vegetation of the most distinctive marsh in this portion of the West Unit, located at the center of SW¼ of section 34, T 37 N, R 7 W, is ranked in Table 3-99. The dominant herb in this community is soft-stem bulrush rather than one of the cattails. An important associate is bluejoint, a grass common in other marshes of the national lakeshore. This is the only marsh we have examined, however, in which large-spiked beakrush is present, and here it is quite abundant and widespread.

The vegetation of the marsh patches in the eastern half of this portion of the West Unit appears to be quite uniform in composition. Along the margins are buttonbush and shining sumac with a rank of 3 or 4. The centers of the marshes are densely packed with both species of cattail, common and narrowleaf; sometimes one species is more important than the other, but in most cases, they are equally ranked at 7. Few other species are present; none is particularly important.

Regular reference has been made above to the marshy area which lies between U.S. 12 and dune ridges to the north; it extends almost all the way across Porter County and westward into Lake County. It is very difficult to traverse much of this marsh on foot because of the general characteristics of marshes, but segments of it can be readily observed from several places.

The westernmost segment of this marsh, coded E-2 on the land use map, extends more than a mile west from County Line Road. It lies within the Nipissing complex. Its vegetation is ranked in Table 3-100. The most important woody plants, located on hummocks and along the margin, are willow and quaking aspen which have not reached tree size. Common cattail is the dominant herbaceous plant; important associates are common reed, northern reedgrass, purple loosestrife, and tall goldenrod.

Extending eastward from County Line Road is a natural continuation of the marsh described in the preceding paragraph. Also coded E-2 and lying within the Nipissing complex, it borders Long Lake on the west, south, and east. The vegetation of this marsh is ranked in Table 3-101. As in the preceding community, willows and common cattail are among the most important shrubs and herbs. In this particular community, however, buttonbush and staghorn sumac are the next most important shrubs. And sharing dominance with common cattail are purple loosestrife, common reed, and soft-stem bulrush. The importance of staghorn sumac in the shrub stratum, the importance of shrubs in general, and the presence in the shrub stratum of immature black oak indicate that the substrate here is considerably drier, in some portions at least, than it is to the west of County Line Road. This community may be considered one in transition from marsh to shrub wetland.

Table 3-99. Stratum ranks of vegetation of marsh in West Unit south of U.S. 12 and east of County Line Road--center of SW¼, section 34, T 37 N, R 7 W.

Cephalanthus occidentalis buttonbush	5	Shrubs
Salix spp. willow shrubs	5	
Populus tremuloides quaking aspen	3	
Scirpus validus soft-stem bulrush	7	Herbs 6 July 78
Calamogrostis canadensis bluejoint	6	
Rhynchospora macrostachya large-spiked beakrush	4	
Phragmites communis berlandieri common reed	4	
Lythrum salicaria purple loosestrife	3	
Lysimachia terrestris yellow loosestrife	2	
Eupatorium perfoliatum common boneset	4	14 Sept. 79
Helianthus giganteus giant sunflower	4	
Bidens coronata crowned tickseed-sunflower	3	
Gerardia purpurea purple gerardia	3	

Table 3-100. Stratum ranks of plant species of marsh in West Unit north of U.S. 12 and west of County Line Road--NW¼ SW¼ SE¼, section 33, T 37 N, R 7 W.

Salix spp. willow shrubs	6	Shrubs
Populus tremuloides quaking aspen	6	
Cephalanthus occidentalis buttonbush	4	
Spiraea alba meadow-sweet	3	
Rubus sp. rasp- black- berry	2	
Typha latifolia common cattail	8	Herbs 11 July 78
Lythrum salicaria purple loosestrife	5	
Calamogrostis inexpansa brevior northern reedgrass	5	
Phragmites communis berlandieri common reed	5	
Eupatorium perfoliatum common boneset	4	
Scirpus validus soft-stem bulrush	4	
Hypericum sp. St.-John's-wort	4	
Polygonum sp. knotweed, smartweed	4	
Potamogeton diversifolius waterthread pondweed	4	
Juncus brevicaudatus short-tailed rush	3	
Lycopus americanus American bugle-weed	3	
Bidens sp. beggar-ticks	3	
Stachys tenuifolia hispida rough hedge-nettle	3	
Sagittaria sp. arrowhead	2	
Asclepias incarnata swamp milkweed	1	
Potentilla fruticosa shrubby cinquefoil	1	
Solidago altissima tall goldenrod	5	15 Sept. 79
Eupatorium perfoliatum common boneset	4	
Solidago graminifolia grass-leaved goldenrod	4	
Eupatorium maculatum spotted Joe-Pye-weed	3	

Table 3-101. Stratum ranks of plant species of marsh in West Unit south of Long Lake--center of NW¼ SW¼, section 34, T 37 N, R 7 W.

Salix spp. willow shrubs	6	Shrubs
Cephalanthus occidentalis buttonbush	5	
Rhus typhina staghorn sumac	5	
Spiraea alba meadow-sweet	4	
Spiraea tomentosa hardhack	4	
Populus tremuloides quaking aspen	4	
Aronia melanocarpa black chokeberry	3	
Populus deltoides cottonwood	3	
Nyssa sylvatica blackgum	2	
Quercus velutina black oak	2	
Viburnum lentago nannyberry	2	
Lythrum salicaria purple loosestrife	6	Herbs 26 July 74
Phragmites communis berlandieri common reed	6	
Scirpus validus soft-stem bulrush	6	
Typha latifolia common cattail	6	
Spartina pectinata cordgrass	5	
Calamogrostis inexpansa brevior northern reedgrass	4	
Carex alata winged sedge	3	
Iris virginica shrevei wild iris	3	
Juncus alpinus rariflorus alpine rush	3	
Juncus brevicaudatus short-tailed rush	3	
Juncus pelocarpus brown-fruited rush	3	
Osmunda regalis spectabilis royal fern	3	
Sagittaria sp. arrowhead	3	
Stachys palustris homotricha marsh hedge-nettle	3	
Thelypteris palustris pubescens marsh fern	3	
Utricularia vulgaris greater bladderwort	3	
Polygonum coccineum swamp smartweed	2	
Scirpus heterochaetus slender bulrush	2	
Verbena stricta hoary vervain	2	
Alisma triviale common water-plantain	1	

From Mineral Springs Road just south of the Dune Acres gatehouse another segment of the marsh, also coded E-2, can be seen extending both to the west and to the east. Both parts lie in the Algonquin dune complex. The part to the west is associated with Cowles Bog and will be described in that context. The part to the east is referred to by local residents as the Great Marsh. Its plants are ranked in Table 3-102. Though willow and aspen were the only tree species observed and could therefore be ranked 7 each, a lower ranking is used to indicate that there are only scattered patches of these trees in the community, on hummocks and along the edges. None of the shrubs is particularly important. The dominant plants of this community are common reed and common cattail.

A third large segment of this long marsh is in the East Unit. It is bounded to the north by Beverly Drive and to the south by the South Shore tracks or forest stands along the tracks, and extends from Kemil Road on the west to where U.S. 12 turns directly to the north just west of Michigan City. As can be seen on the topographic map, this area has been extensively ditched and a number of roads have been extended into or through it. As a result of the lowered water table many more trees are established in this segment of the marsh than elsewhere, and the land use map codes the area as swamp forest, E-3. It is probably better considered for purposes of this chapter as a marsh in a prematurely advanced stage of succession because of the lowered water table. A number of alien species are present in this area as a result of human activity such as road and home building. Because of the lack of naturalness in this area we did not attempt to rank species. Table 3-103, however, provides a list of species observed here.

Between U.S. 12 where it extends in a north-south direction just west of Michigan City and the South Shore tracks, at the center of SW¼ NW¼, section 31, T 38 N, R 4 W, is a 27.7 acre marsh coded E-2, in and around which are some patches of trees coded E-3. The trees are primarily willow and quaking aspen. The shrubs and herbs of this tract are listed in Table 3-104.

In addition to the large expanses of marsh lying just north of U.S. 12 from eastern Lake County to western LaPorte County which are described above, there are dozens of small marshy patches north of these large expanses. Following are several of these small marshes which were selected for study. Though typically coded E-2 on the land use map, those considered late in the sequence have a dryer substrate than the marshes described above and consequently a rather dense shrub cover. A separate category, shrub wetlands, might be erected for the treatment of these stands, but in view of the small number and sizes involved and the difficulty in drawing the line between marshes and shrub wetlands this procedure is not followed.

Table 3-102. Stratum ranking of plant species of Great Marsh in Cowles Unit east of Mineral Springs Road--NE¼ NW¼ SW¼, section 23, T 37 N, R 6 W.

Populus tremuloides quaking aspen	4	Trees
Salix sp. willow	4	
Rosa palustris swamp rose	4	Shrubs
Spiraea alba meadow-sweet	4	
Spiraea tomentosa hardhack	4	
Cephalanthus occidentalis buttonbush	3	
Cornus racemosa gray dogwood	3	
Cornus stolonifera red-osier dogwood	3	
Ilex verticillata winterberry	3	
Sambucus canadensis common elder	3	
Vitis sp. wild grape	1	
Phragmites communis berlandieri common reed	7	Herbs
Typha latifolia common cattail	6	
Impatiens biflora touch-me-not	5	
Aster vimineus small white aster	4	
Solidago altissima tall goldenrod	4	
Asclepias incarnata swamp milkweed	3	
Decodon verticillatus swamp loosestrife	3	
Eupatorium maculatum spotted Joe-Pye-weed	3	
Polygonum lapathifolium pale smartweed	3	
Polygonum sagittatum arrow-leaved tearthumb	3	
Rumex sp. dock	3	
Sagittaria latifolia common arrowhead	3	
Scirpus atrovirens dark-green bulrush	3	
Sparganium americanum American bur-reed	3	
Bidens coronata crowned tickseed-sunflower	2	
Lemna minor lesser duckweed	2	
Scirpus cyperinus wool-grass	2	
Verbena sp. vervain	2	

Table 3-103. List of plant species observed in marsh in East Unit between Beverly Shores Drive and the South Shore tracks--center of section 2, T 37 N, R 4 W.

Acer rubrum red maple	Trees
Acer saccharum sugar maple	
Fraxinus americana white ash	
Liriodendron tulipifera tuliptree	
Populus deltoides cottonwood	
Populus grandidentata bigtooth aspen	
Populus tremuloides quaking aspen	
Prunus pensylvanica pin cherry	
Prunus serotina black cherry	
Salix sp. willow	
Sassafras albidum sassafras	
Ulmus americana American elm	
Cornus stolonifera red-osier dogwood	Shrubs
Rosa palustris swamp rose	
Sambucus canadensis common elder	
Spiraea alba meadow-sweet	
Circuta maculata water-hemlock	Herbs
Cirsium sp. thistle	
Clematis virginiana virgin's-bower	
Echinocystis lobata wild cucumber	
Eupatorium perfoliatum common boneset	
Eupatorium purpureum sweet Joe-Pye-weed	
Impatiens biflora touch-me-not	
Lycopus americanus American bugle-weed	
Lythrum salicaria purple loosestrife	
Oenothera biennis evening-primrose	
Phragmites communis berlandieri common reed	
Phytolacca americana pokeweed	
Pycnanthemum tenuifolium slender mountain-mint	
Solanum carolinense horse-nettle	
Solidago sp. goldenrod	
Urtica procera tall nettle	
Verbascum blattaria moth mullein	

Between the crescent-shaped dune ridge northwest of Long Lake and the new road into the West Beach recreational area, at NE¼ NW¼ SW¼, section 34, T 37 N, R 7 W, is a depression occupied by a marsh and fringed by trees. Its vegetation is ranked in Table 3-105. Aspen is the dominant tree along the margin; common cattail is the dominant plant in the marsh itself.

In the Cowles Unit there is a marsh to the east of the north-south leg of the Northern Indiana Public Service Company sand dike, at NW¼ SE¼ SW¼ section 22, T 37 N, R 6 W. A ditch which extends through it drains water toward the center of the Cowles bog basin. The vegetation of this marsh is ranked in Table 3-106. The dominant woody plants are shrubs, hardhack and black chokeberry; northern reedgrass is the dominant herbaceous species.

In the Cowles Unit west of Mineral Springs Road, at NE¼ NE¼ SW¼, section 22, T 37 N, R 6 W, is a large triangular area coded as marsh on the Dune Acres topographic map and the land use map. Lindsey et al. (1969) show the far eastern tip of this marshy area in a stereopair (Fig. 133, p. 526) and refer to it as a sedge meadow. They point out that it has a well developed Sphagnum mat and list Bidens sp., water smartweed, and Carex sterilis as the dominant herbs. The dominant herbs in the western portion, according to our observations, are common cattail, bulrush (Scirpus sp.), and northern reedgrass (Calamogrostis inexpansa). Buttonbush is an important shrub, and the margin of the marsh is fringed with quaking aspen, paper birch, and blackgum.

Though the large patch coded as marsh just north of this, at SE¼ SE¼ NW¼, section 22, T 37 N, R 6 W, had open water in mid-summer in 1974 and was therefore described above as a pond, along its northern margin are some plant species worthy of special note: pink milkwort (Polygala polygama obtusata), yellow loosestrife (Lysimachia terrestris), lance-leaved loosestrife (Lysimachia lanceolata), many-leaved bulrush (Scirpus polyphyllus), dropseed (Sporobolus heterolepsis), and stargrass (Aletris farinosa).

The trail leading west from the Dune Acres gatehouse is bordered on the north for several hundred yards by a black oak dominated forest described above. Beyond this the trail follows along the south edge of a marsh at SW¼ SE¼ NE¼, section 22, T 37, R 6 W. Clumps of willow and quaking aspen are scattered through the marsh. Important shrubs are buttonbush, meadow-sweet and gray dogwood (Cornus racemosa); also present are common elder, swamp rose, and wild grape. The dominant herbs are common cattail and bulrush (Scirpus sp.).

Extending to the north of the above, just south of West Road in Dune Acres, is still another marsh at SW¼ NE¼ NW¼, section 22, T 37 N, R 6 W. The plants of this marsh are ranked in Table 3-107. This marsh differs considerably from all others in the National Lakeshore. There is a dense growth of shrubs, particularly along the margin, with

Table 3-104. List of shrubs and herbs observed in marsh in East Unit between U.S. 12 and South Shore tracks just west of Michigan City--center of SW¼ NW¼, section 31, T 38 N, R 4 W.

Rubus sp. rasp- black- berry
Sambucus canadensis common elder
Spiraea alba meadow-sweet
Calamogrostis inexpansa brevior northern reedgrass
Clematis virginiana virgin's-bower
Eupatorium perfoliatum common boneset
Eupatorium purpureum sweet Joe-Pye-weed
Impatiens biflora touch-me-not
Oenothera biennis evening-primrose
Physostegia virginiana false-dragonhead
Phytolacca americana pokeweed
Caltha palustris marsh marigold
Scirpus atrovirens dark-green bulrush
Solidago sp. goldenrod
Tradescantia ohiensis common spiderwort
Typha latifolia common cattail
Verbena sp. vervain

Table 3-105. Stratum ranking of plant species of small marsh in West Unit northwest of Long Lake--NE¼ NW¼ SW¼, section 34, T 37 N, R 7 W.

Populus tremuloides quaking aspen	8	Trees
Salix sp. willow	3	
Populus deltoides cottonwood	2	
Cephalanthus occidentalis buttonbush	4	Shrubs
Spiraea alba meadow-sweet	3	
Typha latifolia common cattail	6	Herbs
Sagittaria latifolia common arrowhead	5	
Utricularia vulgaris greater bladderwort	3	

Table 3-106. Stratum ranking of vegetation of a small marshy area in Cowles Unit east of NIPSCO sand dike--NW¼ SE¼ SW¼, section 22, T 37 N, R 6 W.

Salix sp. willow	4	Trees
Populus tremuloides quaking aspen	3	
Nyssa sylvatica blackgum	2	
Aronia melanocarpa black chokeberry	7	Shrubs
Spiraea tomentosa hardhack	7	
Cephalanthus occidentalis buttonbush	4	
Phus vernix poison sumac	2	
Rosa palustris swamp rose	2	
Calamogrostis inexpansa brevior northern reedgrass	6	Herbs
Scirpus sp. bulrush	4	
Typha latifolia common cattail	3	
Cannabis sativa marijuana	2	

Table 3-107. Stratum ranking of plant species of marsh just south of West Raod in Dune Acres--SW¼ NE¼ NW¼, section 22, T 37 N, R 6 W.

Cephalanthus occidentalis buttonbush	7	Shrubs
Spiraea alba meadow-sweet	7	
Galium labradoricum Labrador bedstraw	7	Herbs
Polygonum coccineum swamp smartweed	6	
Scirpus cyperinus wool-grass	6	
Dulichium arundinaceum three-way sedge	4	
Proserpinaca palustris mermaid-weed	4	
Utricularia vulgaris greater bladderwort	4	
Calamogrostis inexpansa brevior northern reedgrass	3	
Nuphar advena spatterdock	3	
Eleocharis smallii marsh spikerush	2	
Hypericum boreale northern St.-John's-wort	2	

Table 3-108. Stratum ranks of vegetation in marshy area east of Mineral Springs Road in Dune Acres--NE¼ NW¼ NW¼, section 23, T 37 N, R 6 W.

Populus tremuloides quaking aspen	6	Trees
Chamaedaphne calyculata angustifolia leather-leaf	4	Shrubs
Salix spp. willow shrubs	4	
Spiraea alba meadow-sweet	4	
Spiraea tomentosa hardhack	4	
Polygonum coccineum swamp smartweed	5	Herbs
Scirpus cyperinus wool-grass	4	
Thelypteris palustris pubescens marsh fern	4	
Calamogrostis inexpansa brevior northern reedgrass	3	
Osmunda regalis spectabilis royal fern	3	
Polytrichum sp. hair-cap moss	3	
Sphagnum sp. peat-moss	3	
Drosera sp. sundew	0*	
Lycopodium lucidulum shining clubmoss	0*	

*Reported by Mrs. Lois Howes

buttonbush and meadow-sweet sharing dominance, yet there is standing water through most of the marsh. The dominant herb in this wet marsh is Labrador bedstraw; wool-grass and swamp smartweed are important associates. Cattail and bulrush are conspicuously absent. Several species in this listing are not present or common elsewhere in the National Lakeshore: Labrador bedstraw, mermaid weed, and northern St.-John's-wort.

East of Mineral Springs Road in the Cowles Unit is a forest immediately north of the Great Marsh; this forest was described above. Within this forest, at SW¼ NW¼ NE¼, section 23, T 37 N, R 6 W, is a small pocket of marsh. In this pocket there is a well developed Sphagnum mat. The only trees are red maple. The most important shrubs are buttonbush and hardhack; also present are speckled alder and poison ivy; ninebark (Physocarpus opulifolius) has been reported. Common herbs are royal, cinnamon, and marsh fern, common cattail, and soft-stem bulrush; also present are nodding bur-marigold (Bidens cernua), tickseed-sunflower (Bidens coronata), boneset, rough-leaved goldenrod (Solidago patula), Aster spp., and lesser duckweed (Lemna minor).

Several hundred yards east of Mineral Springs Road a trail extends northward from the Great Marsh parallel to the road. To the east of this trail are two small marshy areas at the center of NW¼, section 23, T 37 N, R 6 W, and to the west of the trail a somewhat larger one at NE¼ NW¼ NW¼, section 23, T 37 N, R 6 W. The distinctive vegetation of the forest stand in this moist area was described and ranked in Table 3-43 above. The vegetation of the marsh to the west of the trail is ranked in Table 3-108. Of special interest are plants characteristic of bogs: leather-leaf, sundew, and peat-moss. In the smaller patches to the east hardhack and buttonbush are the dominant shrubs, ranking 7 and 6 respectively. Wool-grass is the most important herb, ranking 6; northern reedgrass ranks 4, while three-way sedge and swamp milkweed rank 3.

It was pointed out above that the open black oak stands with prairie vegetation which lie beyond Lupine Lane and Pine Lane in Dune Acres are adjacent to marshy areas. The vegetation of these two marshes, one at SE¼ NE¼ NW¼, section 23, T 37 N, R 6 W, the other at SE¼ SW¼ SE¼, section 14, T 37 N, R 6 W, is so similar that both are ranked together in Table 3-109. This is clearly a shrub wetland. A few species have reached tree size, but they provide little cover. The dominant plants of the community are quaking aspen saplings in the shrub stratum. Black chokeberry is an important associate, and there are numerous other shrub species present. Royal fern is the most important herbaceous species. To the west of the marsh beyond Lupine Lane, at SW¼ NE¼ NW¼, section 23, T 37 N, R 6 W, there is an area coded E-2 (swamp). Here pin oak and white oak, trees which are given a rank of 2 each in the marsh because they are widely scattered there, can each be ranked at 7; they are closely packed and clearly the dominant trees. Immediately west of this swamp is the community whose vegetation was ranked in Table 3-43.

Table 3-109. Stratum ranking of plant species in marshy areas beyond Lupine Lane and Pine Lane in Dune Acres--SE¼ NE¼ NW¼, section 23, T 37 N, R 6 W, and SE¼ SW¼ SE¼, section 14, T 37 N, R 6 W.

Populus deltoides cottonwood	2	Trees
Quercus alba white oak	2	
Quercus palustris pin oak	2	
Populus tremuloides quaking aspen	8	Shrubs
Aronia melanocarpa black chokeberry	6	
Rubus hispidus dewberry	4	
Spiraea alba meadow-sweet	4	
Spiraea tomentosa hardhack	4	
Cornus racemosa gray dogwood	3	
Gaylussacia baccata huckleberry	3	
Salix spp. willow shrubs	3	
Hypericum kalmianum Kalm's St.-John's-wort	2	
Vaccinium corymbosum highbush blueberry	2	
Osmunda regalis spectabilis royal fern	7	Herbs
Thelypteris palustris pubescens marsh fern	4	
Elocharis melanocarpa black-fruited spikerush	3	
Liatris spicata dense blazing-star	3	
Rhynchospora capitellata clustered beakrush	3	
Aletris farinosa star-grass	2	
Xyris caroliniana yellow-eyed grass	2	

Several patches of marsh are located in depressions in the floodplain of the Little Calumet River where it extends through the Bailly Unit. The vegetation of one located at SW¼ NW¼ SE¼, section 27, T 37 N, R 6 W, was ranked. Among the shrubs buttonbush and willow rank 7 and 5 respectively. Among the herbs common cattail ranks 7, common arrowhead ranks 4, and swamp milkweed (Asclepias incarnata), wool grass (Scirpus cyperinus), American bur-reed (Sparganium americanum), spotted Joe-Pye-weed (Eupatorium maculatum), and lesser duckweed (Lemna minor) rank 3 each.

Swamp forests -- In the preceding paragraphs marshes were described in which there are variable amounts of trees. Trees once established tend to become more and more important in wetland communities and eventually a stage is reached in which trees dominate the community. Wetland communities in which trees are the dominant plants are referred to as swamps or swamp forests. Several such swamp forests in the national lakeshore are as follows.

One swamp forest stand is found on the floodplain on the north side of the Little Calumet River just where it flows into the Bailly Unit from the east (at the center of the north margin of NE¼ NE¼, section 34, T 37 N, R 6 W). Its plant species are ranked in Table 3-110. White ash, American elm, and red maple share the dominance in this community. None of the shrubs is particularly important. Spring beauty and swamp buttercup are the most important spring herbs. Wood-nettle is the most important summer herb; goldenrods are important associates.

Another swamp forest on the floodplain of the Little Calumet River that was studied lies in the Bailly Unit one-third of a mile east of Indiana 149. The vegetation of this stand is ranked in Table 3-111. White ash and American elm share dominance with willow in this particular stand; red maple is present but at a low rank. Poison ivy is the most important plant in the shrub stratum. Skunk cabbage is the most important herb in the spring, and as in the preceding stand wood-nettle is the most important summer herb; small white aster is the dominant herb in the fall, and tall goldenrod is an important associate.

There are two swamp forest stands east of State Park Road and just north of the South Shore tracks within the area coded F-1 on the land use map. One stand, bounded by State Park Road on the west, is at NW¼ NW¼ NW¼, section 16, T 37 N, R 5 W. Its vegetation is ranked in Table 3-112. The other stand is a few hundred yards to the east, at the center of S½ SW¼, section 9, T 37 N, R 5 W; most of it lies to the north of Service Road, but it extends also to the south of this road. Its plant species are ranked in Table 3-113. A conspicuous difference between these neighboring stands is the importance of paper and yellow birch in the eastern one and the complete absence of these species in the western one. This is clear from the tables; in the field it is just as obvious, if not more so, even to the unitiated, because of the striking appearance of the birches. What accounts for this difference is difficult to say. Birch tends to be spotty in its distribution in this part of its range, and it may be a matter of these species

Table 3-110. Stratum ranks of vegetation in swamp forest on floodplain of Little Calumet River in Bailly Unit--center of N margin of NE¼ NE¼, section 34, T 37 N, R 6 W.

Acer rubrum red maple	6	Trees
Fraxinus americana white ash	6	
Ulmus americana American elm	6	
Populus deltoides cottonwood	4	
Salix sp. willow	4	
Crataegus sp. hawthorn	4	Shrubs
Rhus radicans poison-ivy	4	
Vitis sp. wild grape	4	
Sambucus canadensis common elder	3	
Cephalanthus occidentalis buttonbush	2	
Lindera benzoin spicebush	2	
Tilia americana basswood	2	
Viburnum prunifolium black-haw	2	
Berberis thunbergii Japanese barberry	1	
Claytonia virginica spring-beauty	5	Herbs 13 May 75
Ranunculus abortivus small-flowered buttercup	5	
Asarum canadense wild ginger	3	
Caltha palustris marsh marigold	3	
Trillium recurvatum prairie trillium	3	
Cicuta maculata water-hemlock	1	
Circaea quadrisulcata canadensis enchanter's nightshade	1	
Galium concinnum pretty bedstraw	1	
Smilax lasioneura carrion-flower	1	

Table 3-110 continued

Viola cucullata marsh blue violet	3	
Viola pubescens eriocarpa smooth yellow violet	3	
Cardamine bulbosa bulb bittercress	2	
Chaerophyllum procumbens chervil	2	
Erythronium sp. dog-tooth violet	2	
Isopyrum biternatum false rue anemone	2	
Phlox divaricata blue phlox	2	
Ranunculus abortivus small-flowered buttercup	2	
Laportea canadensis wood-nettle	7	9 Aug. 74
Solidago sp. goldenrod	5	
Boehmeria cylindrica false nettle	4	
Cryptotaenia canadensis honewort	4	
Sanicula marilandica black snakeroot	4	
Geum virginianum rough avens	3	
Rumex mexicanus Mexican dock	3	
Sanicula trifoliata large-fruited snakeroot	3	
Iris virginica shrevei wild iris	2	
Lysimachia nummularia moneywort	2	
Osmorhiza claytoni hairy sweet cicely	2	
Pilea pumila clearweed	2	
Rudbeckia laciniata green-headed coneflower	2	
Saururus cernuus lizard's-tail	2	
Alisma triviale common water-plantain	1	
Carex grayii bur sedge	1	

Table 3-111. Stratum ranks of vegetation in swamp forest on floodplain of Little Calumet River in Bailly Unit east of Indiana 149--SE¼ NE¼ NW¼, section 33, T 37 N, R 6 W.

Fraxinus americana white ash	6	Trees
Ulmus americana American elm	5	
Salix sp. willow	5	
Populus deltoides cottonwood	4	
Acer saccharinum silver maple	3	
Prunus serotina black cherry	3	
Morus rubra red mulberry	3	
Acer rubrum red maple	2	
Rhus radicans poison-ivy	5	Shrubs
Crataegus sp. hawthorn	3	
Parthenocissus quinquefolia Virginia creeper	3	
Rubus sp. rasp- black- berry	3	
Rosa palustris swamp rose	3	
Sambucus canadensis common elder	3	
Vitis sp. wild grape	3	
Cornus sp. dogwood	2	
Ribes sp. currant	2	
Symplocarpus foetidus skunk-cabbage	5	Herbs 25 May 79
Chaerophyllum procumbens chervil	4	
Galium aparine cleavers	4	
Impatiens biflora touch-me-not	4	
Lysimachia nummularia moneywort	4	
Allium canadense wild garlic	3	
Caltha palustris marsh marigold	3	

Table 3-111 continued

Cardamine bulbosa bulb bittercress	3	
Geranium maculatum wild geranium	3	
Iris virginica shrevei wild iris	3	
Ranunculus abortivus small-flowered buttercup	3	
Ranunculus septentrionalis swamp buttercup	3	
Rumex mexicanus Mexican dock	3	
Viola affinis LeConte's violet	3	
Glechoma hederacea ground-ivy	3	
Equisetum arvense field horsetail	2	
Oxalis stricta yellow wood-sorrel	2	
Phlox divaricata blue phlox	2	
Sanicula trifoliata large-fruited snakeroot	2	
Thalictrum dioicum early meadowrue	2	
Sium suave water-parsnip	1	
Laportea canadensis wood-nettle	6	6 July 78
Rudbeckia laciniata green-headed coneflower	5	
Arctium sp. burdock	4	
Geum canadense white avens	3	
Erigeron strigosus narrow-leaved daisy fleabane	3	
Lysimachia quadriflora marsh loosestrife	3	
Pilea pumila clearweed	3	
Erigeron canadensis horseweed	2	
Aster vimineus small white aster	7	12 Sept. 79
Solidago altissima tall goldenrod	5	
Cinna arundinacea woodreed	4	
Helenium autumnale sneezeweed	4	
Verbesina alternifolia wingstem	4	
Campanula americana tall bellflower	3	
Chelone glabra turtlehead	3	
Cuscuta sp. dodder	3	
Eupatorium fistulosum hollow Joe-Pye-weed	3	
Elymus riparius riverbank wild rye	3	
Polygonum virginianum jumpseed	3	
Verbena urticifolia white vervain	3	
Lobelia siphilitica great lobelia	2	
Vernonia altissima ironweed	2	

Table 3-112. Stratum ranks of vegetation in swamp forest north of South Shore tracks just east of State Park Road--NW¼ NW¼ NW¼, section 16, T 37 N, R 5 W.

Acer rubrum red maple	6	Trees
Fraxinus americana white ash	5	
Liriodendron tulipifera tupliptree	5	
Nyssa sylvatica blackgum	5	
Fraxinus nigra black ash	4	
Prunus serotina black cherry	4	
Quercus alba white oak	4	
Quercus rubra red oak	4	
Fagus grandifolia beech	3	
Sassafras albidum sassafras	3	
Carpinus caroliniana blue beech	2	
Ostrya virginiana ironwood	1	
Quercus velutina black oak	1	
Ulmus americana American elm	1	
Lindera benzoin spicebush	7	Shrubs
Parthenocissus quinquefolia Virginia creeper	4	
Hamamelis virginiana witch-hazel	3	
Sambucus canadensis common elder	3	
Viburnum acerifolium mapleleaf viburnum	3	
Rubus sp. rasp- black - berry	2	
Rubus hispidus dewberry	2	
Salix spp. willow shrubs	2	
Vaccinium vacillans dryland blueberry	2	

Table 3-112 continued

Vitis sp. wild grape	2	
Corylus americana hazelnut	1	
Mitchella repens partridge-berry	4	Herbs 23 Aug. 74
Onoclea sensibilis sensitive fern	4	
Osmunda cinnamomea cinnamon fern	4	
Carex pensylvanica Pennsylvania sedge	3	
Carex platyphylla broad-leaved sedge	3	
Fragaria virginiana strawberry	3	
Hackelia virginiana stickseed	3	
Impatiens biflora touch-me-not	3	
Maianthemum canadense false lily-of-the-valley	3	
Medeola virginiana Indian cucumber-root	3	
Pallavicinia sp. bog liverwort	3	
Polygonum arifolium halberd-leaved tearthumb	3	
Sphagnum sp. peat-moss	3	
Dryopteris spinulosa intermedia common woodfern	2	
Boehmeria cylindrica false nettle	2	
Cinna arundinacea woodreed	2	
Circuta maculata water-hemlock	2	
Iris virginica shrevei wild iris	2	
Polystichum acrostichoides Christmas fern	2	
Sanicula trifoliata large-fruited snakeroot	2	
Saururus cernuus lizard's-tail	2	
Scutellaria churchilliana Churchill skullcap	2	
Trientalis borealis starflower	2	
Juncus sp. rush	2	
Alisma triviale common water-plantain	1	
Botrychium dissectum grapefern	1	
Lilium philadelphicum var. andinum wood lilly	1	
Typha latifolia common cattail	1	

Table 3-113. Stratum ranks of vegetation in swamp forest north of South Shore tracks along Service Road--center of S½ SW¼, section 9, T 37 N, R 5 W.

Acer rubrum red maple	7	Trees	
Betula papyrifera paper birch	6		
Nyssa sylvatica blackgum	5		
Betula lutea yellow birch	4		
Fraxinus americana white ash	3		
Liriodendron tulipifera tuliptree	3		
Prunus serotina black cherry	3		
Quercus alba white oak	3		
Quercus bicolor swamp white oak	3		
Quercus palustris pin oak	3		
Carpinus caroliniana blue beech	2		
Quercus rubra red oak	2		
Ulmus americana American elm	2		
Sassafras albidum sassafras	1		
Tilia americana basswood	1		
Lindera benzoin spicebush	6	Shrubs	
Rubus hispidus dewberry	5		
Aronia melanocarpa black chokeberry	3		
Corylus americana hazelnut	3		
Parthenocissus quinquefolia Virginia creeper	3		
Vitis sp. wild grape	3		
Ribes sp. currant	1		
Salix spp. willow shrubs	1		
Carex platyphylla broad-leaved sedge	6	Herbs 23 Aug. 74	

Table 3-113 continued

Maianthemum canadense false lily-of-the-valley	5	
Mitchella repens partridge-berry	5	
Osmunda cinnamomea cinnamon fern	5	
Carex pensylvanica Pennsylvania sedge	3	
Impatiens biflora touch-me-not	3	
Onoclea sensibilis sensitive fern	3	
Osmunda regalis spectabilis royal fern	3	
Pallavicinia sp. bog liverwort	3	
Saururus cernuus lizard's-tail	3	
Solidago sp. goldenrod	3	
Sphagnum sp. peat-moss	3	
Thelpteris palustris pubescens marsh fern	3	
Aster macrophyllus large-leaved aster	2	
Iris virginica shrevei wild iris	2	
Lilium philadelphicum var.andinum wood lily	2	
Botrychium dissectum grapefern	1	
Botrychium virginianum rattlesnake fern	1	
Cicuta maculata water-hemlock	1	
Prenanthes sp. rattlesnake-root	1	
Solidago patula rough-leaved goldenrod	4	4 Oct. 74
Aster lateriflorus woodland white aster	2	
Fragaria virginiana strawberry	2	
Oxypolis rigidior cowbane	1	
Polygonum arifolium halberd-leaved tearthumb	1	
Solidago caesia blue-stemmed goldenrod	1	
Solidago rugosa rugosa thin-leaved rough-stemmed goldenrod	1	

having reached and subsequently becoming established in one stand but not in the other (though the fact that there are two species of birch involved complicates the matter). Spicebush is the most important plant in the shrub stratum of these stands. Cinnamon fern, sensitive fern, and partridge-berry are among the more important herbaceous plants in both stands; even more important in the stand to the east is broad-leaved sedge. The herbaceous vegetation of these stands was not ranked in the spring of the year, but many of the same species listed in the next few stands were observed on a brief visit on May 31, 1974.

On the land use map a large area coded E-3 (swamp) is shown adjacent to the Great Marsh of Dune Acres on the east and south. Study was made on a generally north-south line through the eastern portion of this wetland area, from Waverly Road on the northeast to the South Shore tracks on the south. Interestingly it was discovered that there are three forest types along this transect of slightly over a half a mile.

To the north, between Dunes Creek and the dune ridge north of it, at NW¼ NE¼ NE¼, section 23, T 37 N, R 6 W, is a community whose vegetation is ranked in Table 3-114. Its southern and eastern boundary is at about the 596 foot contour interval of the two foot contour map of this section of the national lakeshore. This stand is similar in several respects to that previously described which extends along the northern margin of the Great Marsh and whose plant species are ranked in Table 3-42. White oak and blackgum are the most important species in both cases, and the trees of both are considerably larger in diameter and height than those on the dune ridge. This stand adjacent to Waverly Road is different, however, in that pin oak, white ash, and tuliptree are present and relatively important, whereas these species were not recorded for the other stand.

Along Dunes Creek and to the south of it, at SW¼ NE¼ NE¼, section 23, T 37 N, R 6 W, is another type of swamp forest. Its tree species are ranked in Table 3-113. The distinguishing characteristic of this stand as compared to that ranked in Table 3-112 is the dominance of swamp white oak, a species not even recorded for that stand. The tree species of these two stands are otherwise, quite similar. The relative importance in both of pin oak, white ash, and tuliptree -- as compared to their absence in the stand along the northern margin of the Great Marsh -- may be noted. The shrubs and herbs of this stand did not appear sufficiently different from those stands adjoining it to warrant a complete listing and separate ranking; however, species recognized here which do not appear in Tables 3-114 and 3-116 are listed in Table 3-115B.

The above forest type gives way on the south, at about the 608 foot contour line of the two foot contour map of this section of the national lakeshore, to still a third forest type; this stand continues south to the South Shore tracks. The vegetation of this stand is ranked in Table 3-114. It is clearly dominated by red maple. It shares

Table 3-114. Stratum ranks of plant species in portion of swamp forest west of Waverly Road dominated by oak and blackgum--NW¼ NE¼ NE¼, section 23, T 37 N, R 6 W.

Nyssa sylvatica blackgum	7	Trees	
Quercus alba white oak	7		
Quercus rubra red oak	7		
Acer rubrum red maple	6		
Prunus serotina black cherry	6		
Quercus palustris pin oak	5		
Fraxinus americana white ash	4		
Liriodendron tulipifera tuliptree	3		
Quercus velutina black oak	3		
Amelanchier sp. serviceberry	2		
Carya ovalis red hickory	1		
Sassafras albidum sassafras	6	Shrubs	
Cornus sp. dogwood	5		
Lindera benzoin spicebush	5		
Vitis sp. wild grape	5		
Diervilla lonicera bush honeysuckle	4		
Hamamelis virginiana witch-hazel	4		
Parthenocissus quinquefolia Virginia creeper	4		
Rubus hispidus dewberry	4		
Crataegus sp. hawthorn	3		
Prunus virginiana choke cerry	3		
Smilax sp. greenbrier	3		
Corylus americana hazelnut	2		
Rubus sp. rasp- black- berry	2		
Ostrya virginiana ironwood	1		
Trillium recurvatum prairie trillium	3	Herbs	29 Apr. 74

Table 3-114 continued

Trillium grandiflorum large-flowered trillium	2	
Osmunda cinnamomea cinnamon fern	6	5 Aug. 74
Osmunda regalis spectabilis royal fern	5	
Pteridium aquilinum latiusculum bracken fern	4	
Solidago sp. goldenrod	4	
Agrimonia pubescens hairy agrimony	3	
Eupatorium purpureum sweet Joe-Pye-weed	3	
Osmorhiza claytoni hairy sweet cicely	3	
Pedicularis canadensis lousewort	3	
Smilacina racemosa false Solomon's-seal	3	
Aralia nudicaulis wild sarsaparilla	2	
Equisetum arvense field horsetail	2	
Galium concinnum pretty bedstraw	2	
Monarda fistulosa wild bergamot	2	
Saururus cernuus lizard's-tail	2	
Corallorhiza maculata spotted coralroot	1	
Habenaria sp. orchis	1	
Pallavicinia sp. bog liverwort	1	
Polygonatum sp. Solomon's-seal	1	
Sphagnum sp. peat-moss	1.	

Table 3-115A. Stratum ranks of tree species in portion of swamp forest west of Waverly Road dominated by swamp white oak--SW¼ NE¼ NE¼, section 23, T 37 N, R 6 W.

Quercus bicolor seamp white oak	7
Quercus palustris pin oak	5
Acer rubrum red maple	4
Quercus rubra red oak	4
Fraxinus americana white ash	3
Liriodendron tulipifera tuliptree	3
Tilia americana basswood	3
Ulmus americana American elm	3
Carpinus caroliniana blue beech	2
Ostrya virginiana ironwood	2
Carya ovalis red hickory	1
Fagus grandifolia beech	1
Populus deltoides cottonwood	1

Table 3-115B. List of herbs in portion of swamp forest west of Waverly Road dominated by swamp white oak that were not found in adjacent portions.

Amphicarpa bracteata hog-peanut
Bidens cernua nodding bur-marigold
Carex lupulina hop sedge
Chelone glabra turtlehead
Lobelia cardinalis cardinal-flower
Myosotis scorpioides true forget-me-not
Oxypolis rigidior cowbane
Penthorum sedoides ditch stonecrop
Scirpus atrovirens dark-green bulrush
Sparganium americanum American bur-reed

Table 3-116. Stratum ranks of plant species in portion of swamp forest west of Waverly Road dominated by red maple--NW¼ NE¼ SE¼, section 23, T 37 N, R 6 W.

Acer rubrum red maple	7	Trees
Fraxinus americana white ash	5	
Carpinus caroliniana blue beech	4	
Quercus rubra red oak	4	
Tilia americana basswood	4	
Fraxinus nigra black ash	3	
Prunus serotina black cherry	3	
Quercus alba white oak	3	
Quercus bicolor swamp white oak	3	
Ulmus americana American elm	3	
Amelanchier sp. serviceberry	2	
Liriodendron tulipifera tuliptree	2	
Salix sp. willow	2	
Ulmus americana American elm	2	
Ostrya virginiana ironwood	1	
Quercus palustris pin oak	1	
Lindera benzoin spicebush	5	Shrubs
Parthenocissus quinquefolia Virginia creeper	4	
Corylus americana hazelnut	3	
Hamamelis virginiana witch-hazel	3	
Prunus virginiana choke cherry	3	
Rubus hispidus dewberry	3	
Viburnum acerifolium mapleleaf viburnum	3	
Cornus florida flowering dogwood	2	
Ribes sp. currant	2	

Table 3-116 continued

Sambucus canadensis common elder	2	
Vitis sp. wild grape	2	
Berberis thunbergii Japanese barberry	1	
Rubus sp. rasp- black- berry	1	
Panax trifolium dwarf ginseng	4	Herbs 29 Apr. 74
Symplocarpus foetidus skunk-cabbage	4	
Anemone quinquefolia wood anemone	3	
Caltha palustris marsh marigold	3	
Cardamine bulbosa bulb bittercress	3	
Claytonia virginica spring-beauty	3	
Ranunculus septentrionalis swamp buttercup	3	
Uvularia grandiflora bellwort	3	
Viola pubescens eriocarpa smooth yellow violet	3	
Anemonella thalictroides rue anemone	2	
Mitella diphylla bishop's-cap	2	
Trillium cernuum macranthum nodding trillium	2	
Viola cucullata marsh blue violet	2	
Viola pallens smooth white violet	2	
Osmunda cinnamomea cinnamon fern	6	30 May 74
Maianthemum canadense false lily-of-the-valley	5	
Allium tricoccum wild leek	4	
Galium triflorum fragrant bedstraw	4	
Podophyllum peltatum May-apple	4	
Aralia nudicaulis wild sarsaparilla	3	
Arisaema triphyllum jack-in-the-pulpit	3	

Table 3-116 continued

Carex intumescens swollen sedge	3	
Fragaria virginiana strawberry	3	
Galium aparine cleavers	3	
Geranium maculatum wild geranium	3	
Mitchella repens partridge-berry	3	
Onoclea sensibilis sensitive fern	3	
Osmorhiza claytoni hairy sweet cicely	3	
Osmunda regalis spectabilis royal fern	3	
Polystichum acrostichoides Christmas fern	3	
Potentilla sp. cinquefoil	3	
Smilacina racemosa false Solomon's-seal	3	
Smilacina stellata starry false Solomon's-seal	3	
Sphagnum sp. peat-moss	3	
Uvularia grandiflora bellwort	3	
Zizia aurea golden Alexanders	3	
Trientalis borealis starflower	2	
Phlox divaricata blue phlox	1	
Carex pensylvanica Pennsylvania sedge	5	14 Aug. 74
Impatiens biflora touch-me-not	5	
Thelypteris palustris pubescens marsh fern	4	
Athyrium filix-femina michauxii lady fern	3	
Boehmeria cylindrica false nettle	3	
Cicuta maculata water-hemlock	3	
Geum canadense white avens	3	
Panicum sp. panic-grass	3	
Polygonum virginianum jumpseed	3	
Sanicula trifoliata large-fruited snakeroot	3	
Actaea pachypoda white baneberry	2	
Circaea quadrisulcata canadensis enchanter's nightshade	2	
Desmodium sp. tick-trefoil	2	
Iris virginica shrevei wild iris	2	
Lycopus rubellus reddish bugle-weed	2	
Caulophyllum thalictroides blue cohosh	1	

many tree species with the swamp white oak dominated stand to the north. But there is a discontinuity between these stands in that pin oak which has a rank of 5 in the swamp white oak stand is present in the red maple woods with a rank of only 1, whereas the black ash which is present in the red maple stand with a rank of 5 was not recorded from the swamp white oak woods. Because of the peculiar growth habit of the pin oak this discontinuity is quite striking in the field.

There is disagreement as to how situations like that described in the preceding paragraphs should be handled. Some prefer to characterize and define the boundaries of several distinct communities, as has been done above. Others prefer to consider this a single continuous community (a continuum) without definable boundaries and to describe the changes in composition along some gradient in the community. Whatever approach one adopts, the important question to be asked is why there is a change in community composition in a given direction, in this case north-south. The answer in this case is probably related to the nature of the substrate and/or to the relationship of the land surface to the water table. That a relationship to the water table may be involved is suggested by the fact that reasonably logical boundaries between community types correspond to contours as described above. As far as substrate is concerned, there are the following differences. The substrate to the north is essentially the sand of the leeward slope of the dune ridges and outwash from these ridges together with organic material from past communities. On the south the land surface represents essentially the beach profile of the Calumet shoreline, that is lacustrine deposits largely of sand, sloping gently downward from the South Shore tracks to the north. In the lower area in between there is a dense accumulation of organic matter, muck and peat, which lies over the lacustrine sand and probably over outwash sand from the north as well.

To the east of the community whose vegetation is ranked in Table 3-116, in the easternmost portion of the Cowles Unit, is another swamp forest. From Waverly Road which borders it on the west there are roadways leading to lots on which cottages are built; but the portion which lies adjacent to Indiana 49 which borders it on the east is relatively undisturbed. The vegetation of this stand is ranked in Table 3-117. This stand is different than any of the previous three. Sharing dominance in the tree stratum are red maple, swamp white oak, and cottonwood; the first two are not surprising in view of the situation to the west, but cottonwood was listed only once in the three communities to the west and there ranked as 1. And three trees on the list were not recorded in the previous three communities: paper birch, SR 3; white pine, SR 3; and sycamore, SR 1. Black chokeberry and spicebush are the most important shrubs; Tartarian honeysuckle, an introduced species, is an important associate. The most important herbs are cleavers and starry false Solomon's-seal in the summer, and blue-stemmed goldenrod in the fall.

In Table 3-118A are listed the invertebrates we collected from the swamp forest on the floodplain of the Little Calumet River in the Bailly Unit east of Indiana 149. In Table 3-119A are listed the invertebrates collected by Texas Instruments from a swamp forest dominated by

Table 3-117. Stratum ranks of plant species of swamp forest between Waverly Road and Indiana 49--S½ NW¼, section 24, T 37 N, R 6 W.

Acer rubrum red maple	6	Trees
Populus deltoides cottonwood	6	
Quercus bicolor swamp white oak	6	
Fraxinus americana white ash	5	
Prunus serotina black cherry	4	
Quercus palustris pin oak	4	
Salix sp. willow	4	
Ulmus americana American elm	4	
Betula papyrifera paper birch	3	
Carpinus caroliniana blue beech	3	
Pinus strobus white pine	3	
Tilia americana basswood	3	
Acer saccharinum silver maple	2	
Carya ovata shagbark hickory	2	
Nyssa sylvatica blackgum	2	
Platanus occidentalis sycamore	1	
Aronia melanocarpa black chokeberry	6	Shrubs
Lindera benzoin spicebush	6	
Lonicera tatarica Tartarian honeysuckle	5	
Cornus rugosa round-leaved dogwood	4	
Cornus racemosa gray dogwood	4	
Parthenocissus quinquefolia Virginia creeper	4	
Rhus radicans poison-ivy	4	
Vitis sp. wild grape	4	
Asimina triloba pawpaw	3	

Table 3-117 continued

Corylus americana hazelnut	3	
Cephalanthus occidentalis buttonbush	3	
Euonymus obovatus running evonymus	3	
Rosa blanda meadow rose	3	
Ribes sp. currant	3	
Rubus sp. rasp- black- berry	3	
Viburnum prunifolium black-haw	3	
Sambucus canadensis common elder	2	
Lonicera dioica limber honeysuckle	2	
Xanthoxylum americanum prickly ash	2	
Berberis thunbergii Japanese barberry	1	
Amelanchier sp. serviceberry	1	
Rhus vernix poison sumac	1	
Galium aparine cleavers	5	Herbs 22 May 79
Smilacina stellata starry false Solomon's-seal	5	
Equisetum arvense field horsetail	4	
Osmorhiza claytoni hairy sweet cicely	4	
Carex pensylvanica Pennsylvania sedge	4	
Cardamine bulbosa bulb bittercress	4	
Cicuta maculata water-hemlock	4	
Senecio aureus golden ragwort	4	
Ranunculus septentrionalis swamp buttercup	4	
Geranium maculatum wild geranium	3	
Trillium recurvatum prairie trillium	3	

Table 3-117 continued

Erigeron annuus daisy fleabane	2	
Iris virginica shrevei wild iris	2	
Podophyllum peltatum May-apple	2	
Galium circaezans wild licorice	2	
Saxifraga pensylvanica Pennsylvania saxifrage	2	
Symplocarpus foetidus skunk-cabbage	2	
Arisaema triphyllum jack-in-the-pulpit	1	
Carex normalis right-angled sedge	1	
Mitella diphylla bishop's-cap	1	
Onoclea sensibilis sensitive fern	5	15 Aug. 78
Agrimonia sp. agrimony	4	
Circaea quadrisulcata canadensis enchanter's nightshade	4	
Geum canadense white avens	4	
Fragaria virginiana strawberry	3	
Impatiens biflora touch-me-not	3	
Maianthemum canadense false lily-of-the-valley	3	
Potentilla sp. cinquefoil	3	
Prenanthes sp. rattlesnake-root	3	
Athyrium filix-femina michauxii lady fern	2	
Boehmeria cylindrica false nettle	2	
Smilacina racemosa false Solomon's-seal	2	
Solidago caesia blue-stemmed goldenrod	5	22 Sept. 79
Aster vimineus small white aster	4	
Polygonum virginianum jumpseed	4	
Aster lateriflorus woodland white aster	3	

Table 3-118A. Invertebrates taken in samples collected July 23, 1980, from swamp forest on floodplain of Little Calumet River in Bailly Unit--SE¼ NE¼ NW¼, section 33, T 37 N, R 6 W. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
COLLEMBOLA			
Poduridae			2
Isotomidae			2
Onychiuridae			4
Entomobryidae			2
Sminthuridae			3
ODONATA			
Agrionidae			
Agrion maculatum	1		
ORTHOPTERA			
Tetigoniidae			
Conocephalus sp.	2		
Microcentrum sp.	2		
THYSANOPTERA			
Thrypidae			2
HEMIPTERA			
Miridae	2		
Nabidae			
Nabis sp.	2		
Pentatomidae			
Podisus maculiventris	2		
Cydnidae			
Galgupha sp.			3
HOMOPTERA			
Cicadellidae			
Draeculacephala sp.	1		
Empoasca sp.	3	2	
Elymana sp.	2		
Cercopidae			
Lepyronia quadrangularis	4		
Philaenus spumarius	3		
Delphacidae	4	1	
Dictyopharidae	1		
Flatidae	2		
Aphididae	2		
COLEOPTERA			
Carabidae			
Platynus sp.			1
Staphylinidae			2
Stenus sp.			1
Lampyridae			
Lucidota sp.	2		
Photuris pennsylvanica		2	
Cleridae			
Phyllobaenus sp.	1		

Table 3-118A continued

	netting/ sweeping	light traps	from litter
COLEOPTERA-Cont.			
Elateridae			1
Melodidae			
Scrites sp.	1		
Mordellidae			
Mordella sp.	1		
Scarabaeidae			
Popillia japonica	2		
Chrysomelidae			
Anoplitus inqequalis	3		
Trirhabda virgata	3		
Curculionidae			
Apion sp.	1		
NEUROPTERA			
Chrysopidae		1	
MECOPTERA			
Bittacidae			
Bittacus sp.	1		
LEPIDOPTERA			
Noctuidae			
Apatela sp.		2	
Eustrotia sp.		2	
Hadena sp.		2	
Geometridae	2		
Pyralidae			
Herculia himonialis	3	1	
DIPTERA			
Tipulidae		2	
Chironomidae	1	4	
Culicidae	1	3	
Sciaridae		2	
Cecidomyiidae	2	3	
Phoridae		1	
Dolichopodidae		1	
Gymnoternus sp.	2	2	
Psilopiella sp.	2		
Psilidae	1		
Tephritidae			
Eutreta sp.	1		
Lauxaniidae		1	
Sapromyza sp.		2	
Drosophilidae	1		
Chloropidae			
Chlorops sp.	1		
Oscinella sp.	2		
Heleomyzidae	2		
Calliphoridae	2		
Muscidae	2		
HYMENOPTERA			
Braconidae	3	2	
Ichneumonidae	2		
Eulophidae	1	2	
Mymaridae	1		
Torymidae	1		
Pteromalidae	2		
Eupelmidae	2		
Formicidae	2		2
PHALANGIDA	4		
ACARINA			4
ARANEIDA	3	2	2
ISOPODA			2
DIPLOPODA			3
CHILOPODA			1

Table 3-118B. Invertebrates taken in abundance from swamp forest on floodplain of Little Calumet River in Bailly Unit.

COLLEMBOLA--springtails
- Onychiuridae
- Sminthuridae

ORTHOPTERA
- Tetigoniidae--long-horned grasshoppers

HEMIPTERA
- Cydnidae--burrower bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Delphacidae--planthoppers

COLEOPTERA
- Staphylinidae--rove beetles
- Lampyridae--fireflies
- Chrysomelidae--leaf beetles

LEPIDOPTERA
- Noctuidae--miller moths
- Pyralidae--snout/grass moths

DIPTERA
- Chironomidae--midges
- Culicidae--mosquitoes
- Cecidomyiidae--gall gnats
- Dolichopodidae--long-legged flies
- Lauxaniidae--lauxaniids
- Chloropidae--frit flies

HYMENOPTERA
- Braconidae--braconids
- Eulophidae--eulophids
- Formicidae--ants

PHALANGIDA--daddy-long-legs

ACARINA--mites

ARANEIDA--spiders

DIPLOPODA--millipeds

Table 3-118C. Trophic levels of invertebrates collected in abundance from swamp forest on floodplain of Little Calumet River in Bailly Unit.

HERBIVORES
- Tetigoniidae--long-horned grasshoppers
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Delphacidae--planthoppers
- Chrysomelidae--leaf beetles
- Noctuidae--miller moths
- Pyralidae--snout/grass moths

PREDATORS
- Staphylinidae--rove beetles
- Lampyridae--fireflies
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Onychiuridae--springtails
- Sminthuridae--springtails
- Chironomidae--midges
- Diplopoda--millipeds

PARASITES
- Braconidae--braconids
- Eulophidae--eulophids

Table 3-119A. Invertebrates taken in sampels collected by Ecological Services of Texas Instruments Incorporated from swamp forest dominated by red maple southest of Cowels Bogg--S½ SE¼ SE¼, section 22, T 37 N, R 6 W, from Texas Instruments (1975-1980).

COLLEMBOLA						
Poduridae					x	x
Isotomidae	x	x	x		x	
Onychiuridae		x				
Entomobryidae	x	x				x
Sminthuridae			x			
EPHEMEROPTERA						
Heptageniidae						
Stenonema sp.			x			
ONONATA						
Aeschinidae				x		
Aeschna sp.					x	
A. verticollis						x
ORTHOPTERA						
Tetigoniidae		x	x		x	
Conocephalus sp.						x
Scudderia furcata						x
Gryllidae		x				
Phasmatidae	x	x	x			
DERMAPTERA						
Forficulidae		x				
PLECOPTERA						
Perlidae						
Perlesta placida		x	x			
PSOCOPTERA						
Pseudocaeciliidae	x	x				
THYSANOPTERA						
Aelothripidae		x				
Thrypidae		x				
HEMIPTERA						
Pleidae						
Plea sp.		x				
Belostomatidae						
Belostoma sp.				x		
Gerridae	x	x				
Gerris sp.			x	x	x	x
Trepobates sp.				x		
Velidae	x	x				
Microvelia sp.			x			
Mesoveliidae	x					
Miridae	x	x	x			
Ceratocapsus luteus						x
Halticus bracteatus		x				
Neolygus sp.						x
Poecilocapsus lineatus			x			
Trigonotylus tarsalis						x

Table 3-119A continued

	1974	1975	1976	1977	1978	1979
HEMIPTERA-Cont.						
Nabidae	x	x				
Nabis sp.			x			x
Reduviidae					x	
Tingidae						
Corythuca sp.		x				
C. contracta		x	x	x		
Leptopharsa sp.		x	x			
Piesmatidae	x					
Lygaeidae						
Ischnodemus falicus	x					
Coreidae						x
Pentatomidae		x				
Peribalus sp.	x					
HOMOPTERA						
Membracidae						
Ceresa sp.			x			
Enchenopa binotata						x
Telamona sp.						x
Cicadellidae	x	x	x	x	x	x
Cicadula sp.						x
Dikraneura sp.				x		
Draeculacephala sp.						x
Empoasca sp.				x		x
Erythoneura sp.				x		
Graphocephala sp.	x		x			x
Gyponana sp.						x
Palus sp.						x
Paraphlepsius sp.				x		
Polyamia sp.				x		
Tylozygus bifidus						x
Cercopidae	x	x	x	x	x	x
Delphacidae		x				
Cixiidae				x		
Achilidae			x			x
Flatidae	x	x				x
Acanaloniidae				x		
Psyllidae				x		x
Aphididae	x	x	x	x		
COLEOPTERA						
Carabidae	x					
Bembidion sp.	x					
Lebia sp.		x				
Omophron sp.	x					
Platynus sp.		x				
Tachys sp.	x				x	
Haliplidae						
Haliplus sp.				x		
Peltodytes sp.	x					
P. muticus				x		
Dytiscidae	x					
Agabus sp.	x	x				
Hydroporus sp.	x	x				
H. consimilis						x

Table 3-119A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA						
Hydrophilidae						
Anacena sp.	x	x				
Cymbiodyta sp.	x					
C. fimbriata			x			
Enrochrus sp.	x					
Paracymus sp.						x
Tropisternus sp.	x					
Staphylinidae	x	x	x			
Conosomus sp.					x	
Falagria sp.					x	
Paederus sp.		x				
Pselaphidae			x			
Cantharidae		x	x			
Cantharis sp.			x			
Podabrus sp.			x			x
Tytthonyx sp.			x			
Lampyridae						
Lucidota sp.		x	x			
Photinus sp.	x	x	x			x
Photuris pennsylvanica			x			
Elateridae	x					
Athous sp.				x		
Hemicrepidius sp.		x	x		x	
Limonius interstitialis					x	
Ptilodactylidae						
Ptilodactyla sp.	x					
Eucnemidae	x					x
Throscidae						
Aulonothroscus sp.	x		x			
Buprestidae						
Taphocerus sp.	x					
Helodidae						
Cyphon sp.		x	x	x		x
Scrites sp.	x	x	x			x
Cryptophagidae						
Paraxontha sp.	x					
Telephanus velox						x
Cucujidae						
Laemopholeus sp.	x					
Colydidae	x					
Phalacridae		x				
Phalacrus sp.			x			
Nitidulidae	x					x
Brachypterus sp.					x	
Cryptarcha ampla			x			
Coccinellidae						
Hippodamia convergens			x			
H. parentheses			x			
Hyperaspis signata	x					x
Psyllobora virginitimaculata	x	x	x			
Scymnus sp.		x				
Euglenidae						
Elonus sp.			x			
Emelinus sp.	x					
Mycetophagidae						
Mycetophagus sp.	x					
Pyrochroidae	x					
Dendroides sp.		x				

Table 3-119A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-Cont.						
Mordellidae						
Mordellistena sp.		x			x	
Alleculidae						
Isomira sericea						x
Tenebrionidae						
Mercantha contracta	x					
Anobiidae		x				
Cryptorama			x			
Bostrichidae						
Lichenophanes sp.	x					
Scarabaeidae						
Ataenius sp.						x
Phyllophaga sp.	x					
Serica sp.	x		x			
Cerambycidae						
Orthosoma brunneum		x				
Anthribidae						
Ishnocerus sp.						x
Chrysomelidae						
Altica sp.	x	x				
Anoplitus sp.		x				
A. inaequalis			x			
Calligrapha sp.		x				
Chalepus sp.	x	x				
Deloyala guttata	x					
Cryptocephalus sp.					x	
Dibolia sp.			x		x	
Longitarsus sp.				x		
Nodonota sp.						x
Pachybrachis sp.					x	
Plagiometriona clavata	x					
Systena marginalis	x					
Trirhabda virgata						x
Curculionidae	x	x		x	x	
Apion sp.			x			
NEUROPTERA						
Chrysopidae	x	x				
MECOPTERA						
Panorpidae		x				
Panorpa sp.	x			x		x
Bittacidae		x				
Bittacus sp.	x			x	x	
TRICHOPTERA						
Hydroptilidae	x					
Leptoceridae						
Athripsodes sp.				x		
Phryganeidae						
Banksiola selina						x
Oligostomis sp.					x	x
Limnephilidae	x					

Table 3-119A continued

	1974	1975	1976	1977	1978	1979
LEPIDOPTERA						
Papilionidae						
Papilio polyxenes				x		
Nymphalidae						
Speyeria diana		x				
Lycaenidae						
Everes comyntas					x	x
Lycaenopsis argiolus		x				
Sphingidae						
Smerinthus jamaicensis		x				
Saturniidae						
Automeris io					x	
Arctiidae						
Halisodota tesselaris			x			
Isia isabella		x				
Noctuidae	x	x	x	x		
Calpe canadensis				x		
Catacula sp.				x		
Leuconycta diphtheroides						x
Trichoplusia ni		x				
Geometridae	x	x		x		
Apicia confusaria						x
Chlorochlamys chlorleucaria		x				
Dyspteris abortivaria	x					
Ectropis crepuscularia			x			
Eustroma diversilineata		x				
Lygris diversilineata			x		x	
Philobia enotata	x					
Physostegania pustularis						x
Sabulodes transversata	x					
Scopula inboundata					x	
Xanthtype coelaria			x			
Lasiocampidae		x				
Malacosoma americanum		x		x		
Limacodidae						
Prolimacodes scapha						x
Pyromorphidae		x				
Pyralidae	x	x		x		
Tortricidae	x					
Micromoths		x	x	x	x	x
DIPTERA						
Tipulidae	x	x	x	x	x	x
Ptychopteridae						
Bittacomorpha clavipes					x	
Ptychoptera sp.				x		
Psychodidae	x	x		x		
Chaoboridae	x	x	x		x	x
Chironomidae	x	x	x	x	x	x
Strictochironomus sp.		x				
Dixiidae						x
Culicidae	x	x	x	x	x	x
Mycetophilidae	x				x	
Sciaridae	x	x	x		x	x
Cecidomyiidae	x	x	x	x	x	x
Ceratopogonidae		x	x		x	x
Stratiomyiidae	x					

Table 3-119A continued

	1974	1975	1976	1977	1978	1979
DIPTERA-Cont.						
Threvidae			x			
Phoridae	x	x			x	x
Empididae	x	x	x	x		
Chelipoda sp.						x
Hybos sp.					x	
Tachypeza sp.					x	
Dolichopodidae	x	x				
Chrysotus sp.			x	x		
Condylostylus			x	x		
Dolichopus sp.				x		
Mesorhaga sp.			x			
Sciaphus sp.			x			
Thinophilus				x		x
Pipunculidae	x					
Syrphidae		x				x
Conopidae				x		
Otitidae		x				x
Sepsidae		x				
Lauxaniidae	x	x				
Minettia sp.				x		x
Sapromyza sp.			x	x	x	x
Sphaeroceridae	x	x			x	
Drosophilidae		x				
Chymomyza sp.						x
Chloropidae	x	x				
Agromyzidae		x		x		x
Anthomyiidae	x	x				
Clusiidae	x					
Clusiodes sp.			x			
Heteromingia sp.			x			
Calliphoridae	x					
Muscidae	x	x	x		x	x
Tachinidae		x				
HYMENOPTERA						
Tenthredinidae		x	x			x
Braconidae	x	x	x	x	x	x
Ichneumonidae	x	x	x	x	x	x
Eulophidae	x					
Prototrupidae			x			
Cynipidae	x					
Dryinidae						x
Ceraphronidae		x				
Formicidae	x	x	x	x	x	x
Sphecidae		x				
Halictidae						x
Apidae						
Apis mellifera	x					
Xylocopa virginica		x				
PSEUDOSCORPIONIDA			x			
PHALANGIDA			x	x	x	x
ACARINA	x	x	x		x	x
Dermacentor variabilis				x		
ARANEIDA	x	x	x	x	x	x
AMPHIPODA	x	x		x	x	x
ISOPODA		x		x		x
DIPLOPODA					x	
CHILOPODA	x					

Table 3-119B. Invertebrates collected in four of six sample years from swamp forest dominated by red maple southeast of Cowles Bog.

COLLEMBOLA--springtails
- Isotomidae

ORTHOPTERA
- Tetigoniidae--long-horned grasshoppers

HEMIPTERA
- Gerridae--water striders
- Miridae--plant bugs
- Nabidae--damsel bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Aphididae--plantlice

COLEOPTERA
- Hydrophilidae--water scavenger beetles
- Staphylinidae--rove beetles
- Lampyridae--fireflies
- Elateridae--click beetles
- Helodidae--marsh beetles
- Nitidulidae--sap beetles
- Coccinellidae--ladybird beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles

MECOPTERA
- Panorpidae--common scorpionflies

LEPIDOPTERA
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chaoboridae--phantom midges
- Chironomidae--midges
- Culicidae--mosquitoes
- Sciaridae--dark-winged fungus gnats
- Cecidomyiidae--gall gnats
- Ceratopogonidae--biting midges
- Phoridae--humpbacked flies
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Lauxaniidae--lauxaniids
- Muscidae--muscid flies

HYMENOPTERA
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps
- Formicidae--ants

PHALANGIDA--daddy-long-legs

ACARINA--mites

ARANEIDA--spiders

AMPHIPODA--scuds

Table 3-119C. Trophic levels of invertebrates collected in four of six sample years from swamp forest dominated by red maple southeast of Cowles Bog.

HERBIVORES
- Tetigoniidae--long-horned grasshoppers
- Miridae--plant bugs
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Aphididae--plantlice
- Elateridae--click beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths

PREDATORS
- Gerridae--water striders
- Nabidae--damsel bugs
- Staphylinidae--rove beetles
- Lampyridae--fireflies
- Coccinellidae--ladybird beetles
- Chaoboridae--phantom midges
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Isotomidae--springtails
- Hydrophilidae--water scavenger beetles
- Nitidulidae--sap beetles
- Panorpidae--common scorpionflies
- Chironomidae--midges
- Phoridae--humpbacked flies
- Amphipoda--scuds

PARASITES
- Ceratopogonidae--biting midges
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps

red maple; that stand, which lies just north of the South Shore tracks west of Mineral Springs Road, is comparable to the stand dominated by red maple whose vegetation is ranked in Table 3-116 which lies one mile to the east just north of the South Shore tracks and west of Waverly Road. The number of families represented in the collections from the red maple forest stand is 143, which number is exceeded in the communities being considered in this study only by the 157 taken from the stable foredune community. We took a total of 62 families in our collections from the floodplain community, the largest number taken in any of our collections on a single date. Indications are, therefore, that swamp forests provide suitable habitat for a great variety of invertebrates.

In Tables 3-118B, 3-118C, 3-119B, and 3-199C are listed of invertebrates taken in abundance, or in four of six sample years, and the trophic levels they occupy. Leafhoppers, spittlebugs, and several moth families are again among the abundant herbivores; new families in this category in these swamp forests are long-horned grasshoppers and leaf beetles. Long-legged flies and spiders are again among the abundant predators; new families in this category are fireflies and rove beetles. Springtails and midges are again among the abundant scavengers; five additional families of scavengers were taken in four of the six sample years in the red maple forest. The braconids are the only parasites found in abundance in both collections; ichneumon wasps were taken in all six sample years from the red maple forest, and are present in small numbers in the collections from the floodplain forest.

Bogs -- Cowles Bog and Pinhook Bog are two well known features of the Indiana Dunes National Lakeshore. In the introductory paragraphs this section on wetlands a distinction was made between marshes, swamps, and bogs (or peatlands) in general terms. A more detailed consideration of these distinctions and of peatland types is in order before preceding to a discussion of the organisms observed and collected in the national lakeshore bogs.

A detailed comparison of marshes and swamps on one hand and bogs on the other has been made by Sansereau and Segadas-Vianna (1952); their distinctions are summarized in a table which is copied and presented here as Table 3-120. Several characteristics of bogs are particularly worthy of note. 1) The substrate is almost completely organic, and it is in the form of peat. Breakdown of plant materials is incomplete because of low water temperature, anaerobic conditions, and possibly other conditions that prevail in bog waters. Marshes and swamps, on the other hand, have substrates which are high in mineral content, and in them the organic materials are almost completely broken down to a very fine-grained material called muck. This is the characteristic emphasized in the introductory paragraphs of this section on wetlands. 2) In bogs filling takes place as a mat of vegetation, which begins at the margin and extends toward the center, develops on the surface of the water. In time this mat becomes massive, capable of supporting shrubs and possibly trees, and extensive, covering most if not all the water surface. But it is a mat -- that is, it floats on the water. It is only some time later that the organic material, much of it from below the mat, accumulates so as to fill the space beneath it. This is

Table 3-120 A list of contrasting characters used to distinguish bogs from marshes and swamps. From Dansereau and Segadas-Vianna (1952).

Bog	Marsh and Swamp
PHYSIOGRAPHY	
Blocked drainage causes an indefinite accumulation of organic materials; a small quantity of mineral soil is introduced by seepage, inwash, and atmospheric agents.	Drainage pattern does not allow a considerable accumulation of organic materials; the shallow substratum and seepage permit a thorough mixture of organic and mineral sediments.
Drainage is further congested by the growth of a bog: several small bogs can thus unite and modify the drainage pattern over a fairly large expanse. This process is reversed only in the very late stage, when trees cover the area.	Drainage is gradually, if slowly, improved by the growth of swamp vegetation and the corresponding sedimentation.
Open water is invaded by a floating mat and pools are filled in from the top as well as from the bottom. Development often cyclical.	Open water is mostly invaded by non-floating vegetation and filling-in is from the bottom upwards. Development not cyclical.
PHYSICAL CONDITIONS	
Water table reaches the surface in the spring and is below the surface during the rest of the year. Often, phreatic level is just below the surface in the spring and considerably lower in mid-summer.	Water table well above the surface in the spring and just at surface or little below it during the rest of the year.
Water surface often discontinuous when above soil level.	Water surface continuous when above soil level.
Adjacent open water generally brownish (dystrophic).	Adjacent open water generally turbid, olive-green or dark green (eutrophic).
Substratum cohesive, resilient, can uphold considerable weight (e.g. man).	Substratum soft, will absorb heavy objects, will not resist pressure.
Substratum almost 100% organic and always in the form of peat; mineral content low.	Substratum with variable percentage of organic materials, usually not peat but muck; mineral content high.
A false bottom forms in open water, due to accumulation of colloids.	No false bottom.
CHEMICAL CONDITIONS	
Predominance of strongly acid reaction. Percentage of saturation low.	Acid or alkaline reaction. Percentage of oxygen saturation high.
Large quantity of colloids in suspension.	Small quantity of colloids in suspension.
Potassium and nitrogen deficient in soil (although some nitrogen-fixing bacteria).	Potassium and nitrogen not deficient.
VEGETATION	
Presence (at some time) of a floating mat usually dominated by ericoid plants.	Mat, when present, composed of graminoid plants.
Physiognomic dominance of curvilinear contours: much-branched shrubs, cushion-like tufts of herbs and mosses, etc., curved surface of raised bogs.	Physiognomic dominance of rectilinear contours: graminoid herbs, flat surface of soil.
On the whole, a bog is a large cushion.	On the whole, a swamp is a wet prairie.
Dominance of the ericaceous type in many of the pioneer stages.	Dominance of the graminoid type in the pioneer stages.
Dominance of needle-leaved types in the subclimax stages.	Dominance of broadleaved types in the subclimax stages
Vegetal cover continuous, uneven, forming cushions, eventually parklike.	Vegetal cover discontinuous, in tufts or individuals isolated, eventually thicket-like.
Chamaephytes dominant in early stages.	Helophytes, geophytes, and hemicryptophytes dominant in early stages.
Mosses (mostly *Sphagnum*) forming the lowest layer.	Mosses (at least *Sphagnum*) generally absent.
FAUNA	
Animal life scarce, both in numbers of species and of individuals. Snails absent, spiders and ants often abundant.	Animal life abundant, both in species and in individuals. Snails usually abundant, spiders and ants scarce.

in contrast to ponds in which filling typically occurs as the well-decayed organic matter of plants which grow along their margin (muck) together with silt washed in from the surrounding area accumulate on the bottom; such accumulation begins and is greatest along the margin but extends toward the middle. 3) Bog waters have a peculiar ionic content. It is regarding the details of bog chemistry, and how the ionic content of bog water and substrate affects the ability of plants to survive there, that there have been the most divergent views. A possible resolution of the difficulties is as follows (see Boelter and Verry, 1977; and Heinselman, 1963, in which there is a very useful glossary). The term peatland should be used to describe those wetlands whose substrate is peat. Most of the water supply to some peatlands is that of precipitation, therefore, poor in mineral content; such peatlands are technically called ombrotrophic. Under the ion exchange conditions prevailing under these circumstances there are low pH values and potassium, phosphorus, and/or nitrates are deficient or not readily available to plants. The term bog is most appropriately used in reference to these ombrotrophic peatlands. A significant portion of the water supply to other peatlands is surface or ground water, waters rich in mineral content; such peatlands are termed minerotrophic. Under these circumstances pH is near neutrality and mineral nutrients are present and readily available to plants. Such minerotrophic peatlands are referred to as fens. Bogs and fens in reality simply represent two extremes of a continuum, and a given peatland may very well fall in between the conditions described.

In peatlands Sphagnum (peat-moss) characteristically forms a surface mat or sod. Which plants are associated with the peat-moss is determined by their ability to survive in competition with other plant species under the conditions which prevail in a given peatland. A greater number can be expected to be present in those peatlands (fens being at one extreme) where there are not severe mineral deficiency problems than in those where mineral deficiency problems exist. And as one examines the list which Boelter and Verry (1977, Table 1) provide this expectation is borne out. Of the 37 species listed, 14 are limited to minerotrophic sites; only 3 species are limited to ombrotrophic sites; 20 are present in both types of sites. Many of the plants one typically associates with bogs (such as tamarack, small cranberry, leather-leaf, buckbean, and pitcher-plant) are found on both ombrotrophic and minerotrophic sites; and another, speckled alder, is listed as being limited to minerotrophic sites. It should be pointed out again, however, that even if the above distinctions between bogs and fens are agreed to and even if this listing of plants limited to given sites is completely accurate, bogs and fens are simply extremes of a continuum and many peatlands are likely to fall between them in their characteristics.

Though, for reasons made apparent in the last paragraphs, the term peatland might be the most appropriate nomenclature in the case of Cowles Bog and Pinhook Bog, those names have standing historically and the term bog has long been used in a broad sense to include a variety of pH and mineral nutrient conditions. Therefore, without any conscious of implied intent to prejudge the conditions of these wetlands, we will refer to them as bogs.

That there is a series of successional stages in the life of a bog is generally well known. The general pattern was described soon after the turn of the century by Transeau(1903), and a diagram of bog succession presented by Dachnowski (1912) has been used regularly in biology and geomorphology books. In general terms the process of succession is as follows. A mat of pioneer plants (such as sedges and buckbean) grows into the open water. Filling in spaces in the mat grow Sphagnum and other mosses. The thickened mat with a continuous Sphagnum "sod" supports a variety of other plants. The accumulated weight of these plants causes the mat to sink very slowly, and thus causes filling from the top; but as it sinks the mat continues to grow upward and thus more thick and massive and capable of supporting plants of large size. One of the most common of the plants which early invade the Sphagnum sod is leatherleaf (Chamaedaphne calyculata), a member of the heath family; regular associates are other heaths, lowbush blueberry (Vaccinium angustifolium) and cranberries; sundews; pitcher plants; and royal, cinnamon, and marsh ferns. These plants regularly grow in clumps. Within this zone develops a scattering of shrubs which in time achieve dominance. Among these are mountain holly (Nemopanthus mucronata), winterberry (Ilex verticillata), poison sumac (Rhus vernix), black chokeberry (Aronia melanocarpa), highbush blueberry (Vaccinium corymbosum), and speckled alder (Alnus rugosa). Trees which become established among the shrubs, most commonly tamarack (Larix laricina) and red maple, in turn become dominant. Thus a filling bog can be visualized in its simplest form as a basin in which an open body of water is surrounded by concentric circles of the increasingly mature communities described above. Or, if there is no open water, concentric circles of increasingly mature communities can be expected to surround the least mature.

But because of variabilities in the contours of the filling basin, substrates, inflow or drainage, fires, etc., matters are seldom that simple. A number of these complexities are described by Dansereau and Segadas-Vianna (1952).

It is regularly thought that after a bog basin has been filled it will become occupied by the community type characteristic of the surrounding area. This may often be true, as in the case of the Laurentian shield in Canada described by Dansereau (1946). But Transeau (1903, 1906) questioned whether this occurs in northern Indiana and southern Michigan bogs, and Sheviak and Haney (1973) conclude that this is not the case in Volo bog in Lake County, Illinois.

As well known as Cowles and Pinhook bogs are, as unusual as they are, and as many naturalist groups and biology classes as have visited them over the years, it is strange that very little study of them which resulted in publication has been done since that early in the century by Cowles (1901) and Shelford (1913). In a semipopular book Watts (1957, pp. 64 ff.) reports on a visit of her class to Mineral Springs (Cowles) bog in 1914 and describes the stages of succession of bogs

and lists many plant species found there. But the only recent scientific study of the vegetation of these bogs is that conducted by Lindsey, Schmelz, and Nichols (1969) in the preparation of their Natural Areas in Indiana. As indicated early in this chapter, they used the stratum ranking technique which was adopted for our field work. Because we were unable to work with Prof. Lindsey in the field to gain experience with him in the use of this technique, we wanted in some way to check our rankings against his and his associates. The fact that they had ranked the plant species of these two bogs provided us with that opportunity. Therefore, after we ranked the plant species of each of these bogs having carefully avoided noting their rankings, we compared our data with theirs. These comparisons, and comments regarding correspondence or lack of it, are presented in the tables and paragraphs which follow. We are most grateful to Prof. Lindsey for his reprints dealing with community sampling techniques and his correspondence and discussion with us about the application of the stratum ranking technique.

Cowles Bog lies in the interdunal area between the Calumet beach ridge and more recent dunes. The land use map shows a 260 acre marsh (E-2) to the east and west of Mineral Springs Road with swamp forests (E-3) to the southeast and northwest. That portion of the marsh and the swamp forest to the east of the road were described above. The portion of the marsh to the west of the road and the swamp forest to the northwest are considered here in connection with Cowles Bog because of their close relationship to it. This whole area is a basin within the 610 foot contour. That portion, at the south margin of NW¼ NE¼ SE¼, section 22, T 37 N, R 6 W, in which typical peatland plants are concentrated, located in the field by a semicircular fringe of tamarack to the west, may be considered the center of the bog. But the bog center must be considered in relation to the marsh vegetation to the south and east and to the swamp vegetation to the north and west. For one thing, as will become clear in the discussion which follows, there is no sharp dividing line between the community types involved. Moreover, the quality and quantity of water draining from this basin have an effect on all communities present there either directly or indirectly (a change in a community directly attributable to a change in water quality or quantity may affect an adjoining community in which there is no such direct effect).

The plant species of the swamp forest north and west of the bog center, at the center of NW¼ SE¼, section 22, T 37 N, R 6 W, are ranked in Table 3-121. The plant species of the bog center are ranked in Table 3-122. When the data in these tables are compared with the data of Lindsey et al. (1969, pp. 525-528) a discrepancy appears. They list tamarack and white cedar with ranks of 3 and 1 respectively in their table ranking tree species in the lowland forest; we do not include these species in Table 3-121 in which the plant species of the swamp forest are ranked but rather in Table 3-122. In other words, they and we drew our boundaries at different places: they to include all trees, we where we emerged from a thicket at the edge of the swamp forest into an area with predominantly shrubby vegetation which

Table 3-121. Stratum ranks of vegetation of swamp forest of Cowles Bog basin north and west of bog center--center of NW¼ SE¼, section 22, T 37 N, R 6 W.

Betula lutea yellow birch	7*	Trees
Acer rubrum red maple	6*	
Ulmus americana American elm	4*	
Betula papyrifera paper birch	3*	
Nyssa sylvatica blackgum	3	
Salix sp. willow	3*	
Populus deltoides cottonwood	2*	
Prunus serotina black cherry	2	
Ilex verticillata winterberry	5*	Shrubs
Lindera benzoin spicebush	4*	
Cornus racemosa gray dogwood	3	
Cornus stolonifera red-osier dogwood	3*	
Hamamelis virginiana witch-hazel	3*	
Parthenocissus quinquefolia Virginia creeper	3	
Prunus virginiana choke cherry	3*	
Rhus radicans poison-ivy	3	
Vaccinium corymbosum highbush blueberry	3*	
Vitis sp. wild grape	3*	
Aronia melanocarpa black chokeberry	2	
Clematis virginiana virgin's-bower	2*	
Cornus rugosa round-leaved dogwood	2	
Nemopanthus mucronota mountain-holly	2*	
Rubus sp. rasp- black- berry	2*	
Rubus hispidus dewberry	2	

*Listed by Lindsey, et. al. (1969)

Table 3-121 continued

Sambucus canadensis common elder	2*	
Sambucus pubens red-berried elder	2	
Smilax sp. greenbrier	2*	
Viburnum lentago nannyberry	2*	
Caltha palustris marsh marigold	3	Herbs 22 Apr. 74
Maianthemum canadense false lily-of-the-valley	3	
Viola pallens smooth white violet	2	
Anemone quinquefolia wood anemone	1	
Osmunda cinnamomea cinnamon fern	6	29 May 74
Onoclea sensibilis sensitive fern	3*	
Osmunda regalis spectabilis royal fern	3*	
Ranunculus sceleratus cursed buttercup	3	
Thelypteris palustris pubescens marsh fern	3	
Symplocarpus foetidus skunk-cabbage	5	22 Aug. 74
Boehmeria cylindrica false nettle	4	
Impatiens biflora touch-me-not	4*	
Mitchella repens partridge-berry	4*	
Solanum dulcamara bittersweet nightshade	4*	
Sphagnum sp. peat-moss	4	
Aralia nudicaulis wild sarsaparilla	3*	
Carex pensylvanica Pennsylvania sedge	3	
Coptis groenlandica goldthread	3	
Maianthemum canadense false lily-of-the-valley	3	
Aquilegia canadensis columbine	2	
Aster macrophyllus large-leaved aster	2	
Carex folliculata follicle-bearing sedge	2	
Laportea canadensis wood-nettle	2	
Podophyllum peltatum May-apple	2	
Sagittaria latifolia common arrowhead	2	
Scutellaria churchilliana Churchill skullcap	2	
Epilobium coloratum purple-leaved willow-herb	1	
Liparis loeselli bog twayblade	1	
Pallavicinia sp. bog liverwort	1	
Calopogon tuberosus grass pink	0**	
Cypripedium acaule pink ladyslipper	0**	
Cypripedium reginae showy ladyslipper	0***	

*Listed by Lindsey, et. al. (1969)
**Reported by Mrs. Lois Howes
***Observed by Krekeler and Marks, 1964

Table 3-122. Stratum ranking of plant species at the center of Cowles Bog--S margin of NW¼ NE¼ SE¼, section 22, T 37 N, R 6 W.

Larix laricina tamarack	5*	Trees	
Thuja occidentalis white cedar	1*		
Cornus stolonifera red-osier dogwood	5*	Shrubs	
Cornus racemosa gray dogwood	4		
Cornus rugosa round-leaved dogwood	4		
Rhus vernix poison sumac	4*		
Salix spp. willow shrubs	4*		
Spiraea tomentosa hardhack	4*		
Alnus rugosa americana speckled alder	3*		
Betula pumila dwarf birch	3*		
Ribes sp. currant	3*		
Typha latifolia common cattail	7*	Herbs	22 Aug. 74
Thelypteris palustris pubescens marsh fern	4		
Eupatorium perfoliatum common boneset	3*		
Parnassia glauca grass-of-Parnassus	3*		
Sarracenia purpurea pitcher-plant	3*		
Solidago sp. goldenrod	3		
Campanula aparinoides marsh bellflower	2		
Lobelia kalmii Kalm lobelia	2		
Scirpus americanus sword-grass	2		
Scirpus subterminalis swaying bulrush	2		
Cypripedium candidum white ladyslipper	0**		
Drosera sp. sundew	0***		
Habenaria hyperborea huronensis northern fringed orchid	0***		
Triglochin maritima arrow-grass	0***		

*Listed by Lindsey et. al. (1969)
**Observed by Krekeler and Marks, 1964
***Reported by Mrs. Lois Howes

is fringed on the west by a semicircle of tamarack and a single white cedar. (It is because of this condition at the center of the bog, plus the fact that there is no open water in this portion of the basin, that this bog is to be considered in a late stage of succession.) Because of this difference in grouping the data it is not readily seen whether there is overall agreement between their data and ours. To check this out it is necessary to compare the combined data of their two communities with the combined data of our two communities. The asterisks in Tables 3-121 and 3-122 are derived from such a comparsion. Of forty species listed by both of us three-fourths were ranked with a difference of no more than one rank. They listed eight species that we did not, all but one of which (Phragmites, which we include in the marsh community) were ranked 1 or 2. We listed thirty that they did not; most of them are herbaceous species of low rank and/or recognizable primarily in the spring of the year (whereas their observations were made only on August 24). Two major discrepancies remain. 1) They identify the dominant plant of the center of the bog as narrow-leaved cattail; we identify it, after double checking, as common cattail. 2) They list stiff dogwood (Cornus stricta); we do not include that species, whose range seems to be farther to the south, but rather two other species, gray dogwood (C. racemosa) and round-leaved dogwood (C. rugosa). In sum, discrepancies are minor and/or explainable. Agreement of data far outweighs disagreement. We concur in describing the swamp forest as being dominated by yellow birch and red maple, with spicebush and winterberry important in the shrub stratum. And we both describe the bog center as being dominated by cattail and containing species characteristic of bog habitats such as grass-of-Parnassus and pitcher-plant.

The plant species of the extensive marsh between the bog center and Mineral Springs Road are ranked in Table 3-123. The trees essentially fringe this community to the north. Just to the west of Mineral Springs Road where a culvert extends under the road to give rise to Dunes Creek are several patches of open water much of the year. Certain plants in the list, such as arrowhead, duckweed, and swamp loosestrife, are concentrated in and around these patches of water.

Pinhook Bog is not located in an interdunal area as is Cowles Bog, but rather in a depression in the Valparaiso end moraine. There is a pool on the order of two hundred feet long in the western part of it which is choked with spatterdock (Nuphar advena) and greater bladderwort (Utricularia vulgaris), each ranked as 7, but also with handsome pondweed (Potamogeton pulcher), SR 3. There are some cattail, SR 5, and hardhack, SR 3, along the margin, but the most important plant there, ranking 7, is swamp loosestrife. This is not an association of bog mat plants, and this therefore does not appear to be a body of open water around which increasingly later stages of succession are found in concentric circles. The bog as a whole, rather, is in a late stage of succession as indicated by the fact that tamarack are scattered quite generally through it. Yet there is a great deal of diversity in it. There are a number of small pools chocked with greater bladderwort and/or Sphagnum. There are patches of Sphagnum sod which flex under

Table 3-123. Stratum ranks of vegetation of Cowles Bog basin between the bog center and Mineral Springs Road--NE¼ NE¼ SE¼, section 22, T 37 N, R 6 W.

Salix sp. willow	5	Trees
Populus tremuloides quaking aspen	3	
Populus deltoides cottonwood	2	
Cornus racemosa gray dogwood	7	Shrubs
Rhus vernix poison sumac	5	
Spiraea alba meadow-sweet	4	
Spiraea tomentosa hardhack	4	
Alnus rugosa americana speckled alder	3	
Cephalanthus occidentalis buttonbush	3	
Cornus stolonifera red-osier dogwood	3	
Ilex verticillata winterberry	3	
Ribes sp. currant	3	
Rosa palustris swamp rose	3	
Vitis sp. wild grape	3	
Aronia melanocarpa black chokeberry	2	
Typha latifolia common cattail	8	Herbs 22 Aug. 74
Calamogrostis inexpansa brevior northern reedgrass	5	
Decodon verticillatus swamp loosestrife	4	
Thelypteris palustris pubescens marsh fern	4	
Carex comosa bristly sedge	3	
Eupatorium maculatum spotted Joe-Pye-weed	3	
Eupatorium perfoliatum common boneset	3	
Impatiens biflora touch-me-not	3	
Phragmites communis berlandieri common reed	3	

Table 3-123 continued

Sagittaria latifolia common arrowhead	3	
Scirpus americanus sword-grass	3	
Scirpus atrovirens dark-green bulrush	3	
Scirpus cyperinus wool-grass	3	
Scirpus validus soft-stem bulrush	3	
Solidago sp. goldenrod	3	
Sparganium americanum American bur-reed	3	
Lemna minor lesser duckweed	2	
Polygonum punctatum dotted smartweed	2	
Potentilla palustris marsh cinquefoil	2	
Polygonum sagittatum arrow-leaved tearthumb	4	20 Sept. 74
Asclepias incarnata swamp milkweed	3	
Bidens cernua nodding bur-marigold	3	
Bidens coronata crowned tickseed-sunflower	3	
Polygonum lapathifolium pale smartweed	3	
Solanum dulcamara bittersweet nightshade	3	
Aster vimineus small white aster	2	
Rumex sp. dock	2	
Urtica procera tall nettle	2	
Chelone glabra turtlehead	1	

one's weight. There are clumps of low shrub. And there are thickets of high shrub which are practically impossible to penetrate.

Borings into the peat of bogs and examination of the undecomposed pollen grains from different levels have been used to develop a picture of the change over the centuries of the neighboring plant communities (Potzger, 1956; Deevey, 1949a, 1949b). Guennel's (1950) borings into Pinhook Bog confirm the general pattern of succession in the region which is described by Petty and Jackson (1966).

Our ranking of the vegetation of Pinhook Bog is presented in Table 3-124. The rankings of Lindsey et al. (1969) are included for comparison. Their rankings and ours are in remarkable agreement, seldom differing by more than one rank. There is a difference of three ranks for tamarack, however. In a conversation with Lindsey after our field ranking was done we learned that Lindsey and his associates use the rank of 9 to designate an almost pure stand in a given stratum even though the plants are sparse. In our ranking of this community, and others as has been pointed out in the commentary above from time to time, we took sparseness into account in ranking, thus would assign a rank of 9 only if a tree species exhibited almost continuous cover. They list only two species, each with a rank of 2, that we did not recognize. We list about a dozen species that they do not, most of which are recognizable primarily in the spring (whereas their observations were made only on August 23) and/or are ranked as 2 or 1. Other items on which there is disagreement are as follows: 1) we list huckleberry and swamp loosestrife with ranks of 5 and 3 respectively, they do not list them; 2) they refer in their text to peatmoss as forming the basal matrix, but do not rank it as we do; 3) they list only one species each of cranberry and sundew whereas we list and rank two species of each. But still there is such close correspondence between their ranking and ours in this community as well as those in the Cowles Bog basin to assure us that we have applied the stratum ranking technique--except as noted above--in conformity with their practice.

Note should be made of the fact that in and near the extreme southern lobe of the bog there are a number of dead tamarack trees and shrubs of several species. A salt pile along the toll road has been covered with a shelter so there is no longer runoff from it into the bog. But there is a culvert which carries water from the highway and berms toward this lobe of the bog, and salts and other materials from the highway carried in this water are most likely responsible for the death of these plans.

In Tables 3-125A and 3-126A are listed the invertebrates collected by Ecological Services of Texas Instruments Incorporated from the swamp forest west of the center of Cowles Bog and the marsh south of the bog center. In Table 3-127A are listed the invertebrates we collected from Pinhook Bog on a single date in 1980. The number of families taken from the swamp forest, 125, is very close to the number taken from the young and mature black oak forests (127 and 126 respectively), slightly lower than the number (143) taken from the red maple forest southeast

Table 3-124. Stratum ranks of vegetation of Pinhook Bog--center of section 35, T 37 N, R 4 W--as determined by different groups.

	Krekeler & Marks	Lindsay et. al.	
Larix laricina tamarack	6	9	Trees
Pinus strobus white pine	4	2	
Acer rubrum red maple	2	2	
Vaccinium corymbosum highbush blueberry	7	7	Shrubs
Chamaedaphne calyculata angustifolia leather-leaf	6	7	
Aronia melanocarpa black chokeberry	5	6	
Gaylussacia baccata huckleberry	5		
Caphalanthus occidentalis buttonbush	3	2	
Ilex verticillata winterberry	3	2	
Nemopanthus mucronota mountain-holly	3	3	
Populus tremuloides quaking aspen	3	2	
Salix spp. willow shrubs	3	2	
Spiraea tomentosa hardhack	3	2	
Quercus alba white oak	2	1	
Quercus rubra red oak	2	1	
Rubus sp. rasp- black- berry	2	2	
Sambucus canadensis common elder	2	2	
Sphagnum sp. peat-moss	7		Herbs 26 June 74
Hypericum ellipticum pale St.-John's-wort	4		
Cypripedium acaule pink laydslipper	3	2	
Drosera intermedia spatulate-leaved sundew	3	4	
Drosera rotundifolia round-leaved sundew	3	4	

Table 3-124 continued

	Krekeler & Marks	Lindsay et. al.	
Pogonia ophioglossoides rose pogonia	3		
Typha latifolia common cattail	3	2	
Lycopus americanus American bugle-weed	2		
Sagittaria latifolia common arrowhead	2	2	
Scirpus americanus sword-grass	2		
Eriophorum virginicum cotton-grass	5	2	23 Aug. 74
Sarracenia purpurea pitcher-plant	4	3	
Vaccinium macrocarpon large cranberry	4		
Decodon verticillatus swamp loosestrife	3		
Habenaria ciliaris orange fringed orchid	3	3	
Impatines biflora touch-me-not	3	2	
Osmunda cinnamomea cinnamon fern	3	3	
Osmunda regalis spectabilis royal fern	3	4	
Thelypteris palus-ris pubescens marsh fern	3	4	
Triadenum virginicum marsh St.-John's-wort	3	3	
Woodwardia virginica Virginia chainfern	3	3	
Agrimonia parviflora small-flowered agrimony	2		
Eleocharis obtusa blunt spikerush	2	3	
Iris virginica shrevei wild iris	2	2	
Juncus balticus littoralis lakeshore rush	2	2	
Juncus canadensis Canadian rush	2		
Maianthemum canadense false lily-of-the-valley	2		
Menyanthes trifoliata minor buckbean	2		
Polygonum coccineum swamp smartweed	2	2	
Potentilla palustris marsh cinquefoil	2		
Rhynchospora capitellata clustered beakrush	2	2	
Saururus cernuus lizard's-tail	2	2	
Scirpus cyperinus wool-grass	2		
Solidago sp. goldenrod	2	2	
Vaccinium oxycoccus small cranberry	2	3	
Andromeda glaucophylla bog rosemary	1	2	
Polytrichum sp. hair-cap moss	1	1	

Table 3-125A. Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from swamp forest west of Cowles Bog--center of NW¼ SE¼, section 22, T 37 N, R 6 W.

	1974	1975	1976	1977	1978	1979
COLLEMBOLA						
Poduridae	x	x			x	x
Isotomidae	x	x	x		x	
Entomobryidae	x	x	x			x
Sminthuridae						x
ODONATA						
Libellulidae		x				
Sympetrum sp.			x			
Coenagrionidae		x				
ORTHOPTERA						
Tetrigidae						x
Tettigoniidae						
Conocephalus sp.			x			
Gryllidae	x					
Oecanthus sp.			x		x	
DERMAPTERA						
Forficulidae	x				x	
PSOCOPTERA						
Psocidae			x			
Pseudocaeciliidae	x				x	
Polypsocidae		x		x		
THYSANOPTERA						
Phloeothripidae	x					
HEMIPTERA						
Corixidae						
Sigara sp.			x			
Notonectidae						
Notonecta sp.					x	
Belostomatidae						
Belostoma sp.	x					
Gerridae	x					
Gerris sp.			x			
Miridae	x	x	x		x	
Ceratocapsus luteus						x
Hyaliodes sp.				x		
Lygus lineolaris			x			
Neurocolpus sp.			x			
Strongylocoris atritibialis	x					
Trigonotylus tarsalis					x	
Nabidae	x	x				
Nabis sp.				x		
Reduviidae	x					
Phymatidae	x					
Phymata sp.						:
Tingidae						
Corythuca sp.		x				

Table 3-125A continued

	1974	1975	1976	1977	1978	1979
HEMIPTERA-Cont.						
Lygaeidae						
Eremocoris sp.				x		
Geocoris sp.					x	
Ischnodemus falicus	x					
Ischnorhynchus resedae	x					
Oedancala sp.			x			
Pentatomidae	x					x
Mormidae lugens					x	
HOMOPTERA						
Membracidae	x					
Ceresa bubalus			x			
Cicadellidae	x	x	x	x	x	x
Chlorotetix sp.					x	x
Cicadula sp.						x
Dikraneura sp.				x		
Empoasca sp.					x	
Erythoneura sp					x	
Graphoecephala sp.	x		x			
Idiocerus sp.					x	
Scophcideus sp						x
Cercopidae	x	x	x	x	x	x
Delphacidae	x			x		
Cixiidae						x
Dictyopharidae	x					
Achilidae			x	x	x	x
Flatidae	x					x
Issidae			x			
Aphididae	x		x	x	x	x
COLEOPTERA						
Cicindelidae					x	
Cicindela sp.		x				
C. scutellaris	x					
Carabidae	x				x	
Clivinia sp.		x				
Lebia viridis			x			
Platynus sp.		x				x
Stenolophus sp.		x				
Tachys sp.				x		
Haliplidae						
Peltodytes muticus			x			
Dytiscidae	x					
Desmopachria sp.			x			
Hydroporus sp.	x	x	x			
H. niger			x			
Hygrotus sp.	x		x			
Hydrophilidae						
Anacena sp.	x					
Berosus sp.	x					
Cymbiodyta sp.				x		
Enochrus sp.	x			x		
Hydrobius sp.	x	x			x	
Hydrochara sp.		x				

Table 3-125A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-Cont.						
Ptiliidae		x				
Acrotrichus sp.	x					
Ptinella sp.					x	
Ptinellodes sp.			x			
Staphylinidae	x	x	x		x	x
Gyrophaena sp.	x					
Paederus sp.	x	x	x			
Pselaphidae		x	x			x
Cantharidae	x					
Cantharis sp.	x	x	x			x
C. rectus	x			x	x	x
Podabrus sp.	x					
Lampyridae						
Photinus sp.	x	x	x			
Photuris sp.			x			x
Pyractonema sp.	x		x			
Elateridae						
Agriotes oblongicollis						x
Hemicrepidius sp.						x
Heteroderes sp.	x					
Limonius basillaris			x			
Melodidae						
Cyphon sp.	x	x	x	x	x	x
Elodes sp.			x			x
Prionocyphon sp.	x		x			x
Scirtes sp.	x	x	x	x		x
Cryptophagidae						x
Lanuriidae						
Acropteroxys sp.	x					
Phalacridae	x					
Stilbus sp.			x			
Coccinellidae						
Cycloneda munda	x					
Hippodamia convergens	x					
Hyperaspis signata						x
Psyllobora virginitimaculata		x				
Scymnus sp.	x		x			
Pyrochroidea sp.						
Dendroides sp.		x				x
Mordellidae						
Mordellistena sp.			x			
Scarabaeidae						
Ataenius sp.		x		x		
Onthophagus janus				x		
Phyllophaga sp.	x					
Cerembycidae						
Anoplodera rubica	x					
Parandra brunnea				x		
Curculionidae	x	x	x		x	
Chrysomelidae						
Anoplitus inaequalis			x		x	
Calligrapha sp.		x				
Chalepus scapularis			x			
Disonychia pennsylvanica	x					
Nodonota sp.					x	
Phaedon viridis						x

Table 3-125A continued

	1974	1975	1976	1977	1978	1979
NEUROPTERA						
Corydalidae	x	x			x	
Hemerobiidae	x		x		x	
Coniopterygidae			x			
TRICHOPTERA						
Limnephilidae	x					
LEPIDOPTERA						
Papilionidae						
Papilio polyxenes				x		
Nymphalidae						
Limenetis archippus	x					
Polygonia interrogationis				x		
Satyridae						
Euptychia mitchelli		x				
Lethe eurydice				x		
L. portlandia				x		
Lycaenidae						
Lycaenopsis argiolus		x			x	
Hesperiidae						x
Epargyreus clarus				x		
Sphingidae						
Paonias myops						x
Noctuidae	x	x	x			
Calpe canadensis				x		
Leucania multilinea						x
Geometridae				x		
Abbotana clemitaria		x				
Eustroma diversilineata	x	x				
Lygris diversilineata				x	x	
Epimecis sp.					x	
Sabulodes transversata	x					
Notodontidae						
Heterocampa guttivittata			x			
Pyralidae		x				
Tortricidae	x	x	x			
Heliozelidae						
Antispila nyssaefoliella	x					
Micromoths		x	x	x	x	x
DIPTERA						
Tipulidae	x	x	x	x	x	x
Ptychopteridae						
Bittacomorpha clavipes	x		x			
Psychodidae	x	x	x			
Chaoboridae	x	x		x	x	x
Chironomidae	x	x	x	x	x	x
Dixiidae			x			
Bibionidae						
Bibio sp.			x			
Culicidae	x	x	x	x	x	x

Table 3-125A continued

	1974	1975	1976	1977	1978	1979
DIPTERA-Cont.						
Mycetophilidae	x	x		x	x	x
Sciaridae	x	x	x	x		x
Cecidomyiidae		x	x	x		
Ceratopogonidae	x	x	x	x	x	x
Stratiomyiidae	x					
Odontomyia sp.						x
Tabanidae	x					
Chrysops sp.	x	x				
C. vittatus		x	x	x		
Tabanus sp.	x					
Threvidae				x		
Phoridae	x	x		x	x	x
Empididae	x	x	x	x		x
Chelipoda sp.				x	x	
Hybos sp.						x
Tachypeza sp.						x
Dolichopodidae	x	x				
Chrysotus sp.				x	x	
Dolichopus sp.				x	x	
Gymnoternus sp.					x	x
Helastoneurus sp.						x
Sciaphus sp.						x
Thinophilus sp.				x	x	x
Syrphidae	x					x
Otitidae			x			x
Eumetopiella sp.			x			
Micropezidae	x					x
Sepsidae	x	x				
Sepsis sp.			x			
Sciomyzidae						
Heplodictya sp.			x			
Tetanocera sp.			x			
Lauxaniidae	x	x				
Sapromyza sp.				x	x	
Piophilidae				x		
Sphaeroceridae	x	x	x			
Leptocera sp.			x	x		x
Ephydridae	x	x				
Artissa sp.				x		
Dichaeta sp.				x		
Drosophilidae	x	x	x			
Chymomyza sp.				x		x
Drosophila sp.				x		
Chloropidae	x	x				
Epichlorops sp.						x
Hippelates sp.					x	
Oscinella sp.						x
Agromyzidae	x					
Anthomyiidae	x	x				
Clusiidae	x	x				
Muscidae	x	x			x	x
Tachinidae	x				x	

Table 3-125A continued

	1974	1975	1976	1977	1978	1979
HYMENOPTERA						
Tenthredinidae	x				x	
Braconidae	x	x	x		x	x
Ichneumonidae	x	x	x	x	x	x
Perilampidae	x					
Pteromalidae		x			x	
Eurytomidae		x				
Evaniidae			x			
Cynipidae				x		x
Formicidae	x	x	x	x	x	x
Apidae						
Apis mellifera		x				
Xylocopa virginica		x				x
PSEUDOSCORPIONIDA	x	x	x		x	
PHALANGIDA				x	x	x
ACARINA	x	x	x		x	x
ARANEIDA	x	x	x	x	x	x
AMPHIPODA		x				
ISOPODA		x				
CLASS DIPLOPODA					x	

Table 3-125B. Invertebrates collected in four of six sample years from swamp forest northwest of Cowles Bog.

COLLEMBOLA--springtails
- Poduridae
- Isotomidae
- Entomobryidae

HEMIPTERA
- Miridae--plant bugs
- Lygaeidae--seed bugs

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Achilidae--planthoppers
- Aphpididae--plantlice

COLEOPTERA
- Carabidae--ground beetles
- Hydrophilidae--water scavenger beetles
- Ptiliidae--feather-winged beetles
- Staphylinidae--rove beetles
- Cantharidae--soldier beetles
- Lampyridae--fireflies
- Elateridae--click beetles
- Helodidae--marsh beetles
- Coccinellidae--ladybird beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles

LEPIDOPTERA
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths

DIPTERA
- Tipulidae--crane flies
- Chaoboridae--phantom midges
- Chironomidae--midges
- Culicidae--mosquitoes
- Mycetophilidae--fungus gnats
- Sciaridae--dark-winged fungus gnats
- Ceratopogonidae--biting midges
- Tabanidae--horse/deer flies
- Phoridae--humpbacked flies
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Lauxaniidae--lauxanilds
- Sphaeroceridae--small dung flies
- Drosophilidae--small fruit flies
- Chloropidae--frit flies
- Muscidae--muscid flies

HYMENOPTERA
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps
- Formicidae--ants

PSEUDOSCORPIONIDA--pseudoscorpions

ACARINA--mites

ARANEIDA--spiders

Table 3-125C. Trophic levels of invertebrates collected in four of six sample years from swamp forest northwest of Cowles Bog.

HERBIVORES
- Miridae--plant bugs
- Lygaeidae--seed bugs
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Achilidae--planthoppers
- Aphididae--plantlice
- Elateridae--click beetles
- Chrysomelidae--leaf beetles
- Curculionidae--snout beetles
- Noctuidae--miller moths
- Geometridae--measuringworms
- Micromoths

PREDATORS
- Carabidae--ground beetles
- Staphylinidae--rove beetles
- Lampyridae--fireflies
- Coccinellidae--ladybird beetles
- Chaoboridae--phantom midges
- Empididae--dance flies
- Dolichopodidae--long-legged flies
- Pseudoscorpionida--pseudoscorpions
- Araneida--spiders

SCAVENGERS
- Poduridae--springtails
- Isotomidae--springtails
- Entomobryidae--springtails
- Hydrophilidae--water scavenger beetles
- Ptiliidae--feather-winged beetles
- Chironomidae--midges
- Phoridae--humpbacked flies
- Sphaeroceridae--small dung flies

PARASITES
- Ceratopogonidae--biting midges
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps

Table 3-126A Invertebrates taken in samples collected by Ecological Services of Texas Instruments Incorporated from marsh south of center of Cowles Bo---, SE¼, SE¼, section 22, T 37 N, R 6 E. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).

ODONATA						
Libellulidae	x					
Plathemis lydia			x			
Coenagrionidae						
Enallagma sp.		x				
Ischnura sp.						x
HEMIPTERA						
Corixidae	x	x				
Sigara sp.			x			
Notonectidae						
Notonecta sp.	x					x
Pleidae						
Plea sp.	x	x		x		
Belostomatidae						
Belostoma sp.	x	x			x	
Gerridae						
Gerris sp.				x		x
Veliidae	x					
Nepidae						
Ranatra sp.	x		x			
COLEOPTERA						
Haliplidae	x					
Haliplus sp.			x	x	x	x
Peltodytes sp.	x	x				
P. 12-punctatus			x			
P. muticus			x	x		
Dytiscidae	x					
Comptotomus sp.				x		
Agabus sp.		x	x	x		x
Desmopachria sp.	x		x			x
Hydroporus sp.	x	x				x
H. consimilis			x	x	x	x
H. niger			x		x	x
Hygrotus sp.	x	x	x	x	x	x
Laccophilus sp.	x	x				
Rhantus sp.	x	x				
Gyrinidae						
Gyrinus sp.			x			
Hydrophilidae						
Anacena sp.	x	x	x			
Berosus sp.	x	x				
Enochrus sp.	x					x
Helophorus sp.				x		x
Hydrobius sp.						x
Paracymus sp.					x	x
Tropisternus sp.	x	x				
Hydrochus sp.	x					
Cantharidae	x	x				
Cleridae						
Enoclerus sp.		x				
Helodidae						
Cyphon sp.	x					
Coccinellidae						
Scymnus			x			

Table 3-126A continued

	1974	1975	1976	1977	1978	1979
COLEOPTERA-Cont.						
Chrysomelidae						
Disonychia pennsylvanica	x					
Oedionychus		x				
Curculionidae					x	
NEUROPTERA						
Corydalidae					x	x
TRICHOPTERA						
Leptoceridae	x					
Triaenodes				x		
Phryganeidae	x					
Limnephilidae	x					
Athripsodes				x		
LEPIDOPTERA						
Papilionidae						
Papilio glaucus	x					
Pieridae						
Colias philodice	x					
Pieris rapae	x					
Danaidae						
Danaus plexippus	x					
Nymphalidae						
Vanessa atalanta		x				
Hesperiidae						
Poanes viator		x				
Arctiidae						
Estigmene congrua		x				
Geometridae	x					
Pyralidae		x				
Micromoths						x
DIPTERA						
Tipulidae	x	x				
Ptychopteridae						
Bittacomorpha clavipes	x		x		x	x
Ptychoptera sp.	x					
Psychodidae					x	
Chironomidae	x	x	x	x	x	x
Ceratopogonidae	x				x	
Stratiomyiidae	x	x				x
Syrphidae	x					
Sciomyzidae	x					
Calliphoridae	x					
ACARINA			x			
AMPHIPODA	x	x			x	x
ISOPODA	x	x		x	x	x

Table 3-126B. Invertebrates collected in four of six sample years from marsh south of center of Cowles Bog.

COLEOPTERA
- Haliplidae--crawling water beetles
- Dytiscidae--predaceous diving beetles
- Hydrophilidae--water scavenger beetles

DIPTERA
- Ptychopteridae--phantom crane flies
- Chironomidae--midges

AMPHIPODA--scuds

ISOPODA--sow bugs

Table 3-126C. Trophic levels of invertebrates collected in four of six sample years from marsh south of center of Cowles Bog.

PREDATORS
- Dytiscidae--predaceous diving beetles

SCAVENGERS
- Hydrophilidae--water scavenger beetles
- Ptychopteridae--phantom crane flies
- Chironomidae--midges
- Amphipoda--scuds
- Isopoda--sow bugs

Table 3-127A. Invertebrates taken in samples collected July 29, 1980, from Pinhook Bog. (1 = one; 2 = few; 3 = many; 4 = very many.)

	netting/ sweeping	light traps	from litter
COLLEMBOLA			
Isotomidae			2
ORTHOPTERA			
Tetigoniidae	2		
Gryllidae	1		
HEMIPTERA			
Miridae	1		
Berytidae			
Berytinus sp.	1		
Pentatomidae	1		
Cydnidae			
Allocoris sp.	1		
HOMOPTERA			
Cicadellidae			
Gyponana sp.	3		
Paraphlepsius sp.	2		
Cercopidae			
Aphrophora saratogensis	3		
Clastoptera saint-cyri	4		
Flatidae	2		
Psyllidae	1		
Aphididae	1		
COLEOPTERA			
Carabidae			2
Staphylinidae			1
Cantharidae			
Cantharis rectus	2		
Helodidae			
Cyphon sp.	3		
Prionocyphon sp.			1
Coccinellidae			
Hyperaspis signata	1		
Chrysomelidae			
Chaetocnema sp.	1		
Curculionidae	2		
LEPIDOPTERA			
Geometridae	2		
Philobia enotata		2	
Micromoths	3	1	
DIPTERA			
Tipulidae	2		
Chaoboridae		2	
Chironomidae	1	2	
Culicidae	1	1	

Table 3-127A continued

	netting/ sweeping	light traps	from litter
DIPTERA-Cont.			
Cecidomyiidae		1	
Tabanidae			
Chrysops sp.	1		
Dolichopodidae		1	
Argyra sp.	2		
Tephritidae	3		
Lauxaniidae			
Minettia sp.	2		
Chloropidae			
Chlorops sp.	2		
Calliphoridae	3		
Muscidae		1	
HYMENOPTERA			
Braconidae	3		
Ichneumonidae	3		
Torymidae	1		
Pteromalidae	1		
Chrysididae	1		
Formicidae	3		2
PHALANGIDA	2		
ACARINA			4
ARANEIDA	3		2

Table 3-127B. Invertebrates taken in abundance from Pinhook Bog.

HOMOPTERA
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs

COLEOPTERA
- Helodidae--marsh beetles

LEPIDOPTERA
- Geometridae--measuringworms
- Micromoths

DIPTERA
- Chironomidae--midges
- Dolichopodidae--long-legged flies
- Tephritidae--fruit flies
- Calliphoridae--blow flies

HYMENOPTERA
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps
- Formicidae--ants

ACARINA--mites

ARANEIDA--spiders

Table 3-127C. Trophic levels of invertebrates collected in abundance from Pinhook Bog.

HERBIVORES
- Cicadellidae--leafhoppers
- Cercopidae--spittlebugs
- Geometridae--measuringworms
- Micromoths
- Tephritidae--fruit flies

PREDATORS
- Dolichopodidae--long-legged flies
- Araneida--spiders

SCAVENGERS
- Chironomidae--midges
- Calliphoridae--blow flies

PARASITES
- Braconidae--braconids
- Ichneumonidae--ichneumon wasps

of the bog center. The 44 families taken from the marsh south of the bog center in collections over six years is by far the smallest number taken by the Texas Instruments' team; the next smallest is the 126 families taken from the mature black oak forest. The number of families we took from Pinhook Bog, 39, though the lowest in our set of samples, is only one smaller than the number taken from the oak-hickory forest.

In Tables 3-125B, 3-125C, 3-126B, 3-126C, 3-127B, 3-127C are listed the families taken in four of six sample years, or in abundance in one year, and the trophic levels they occupy. As might be expected, the invertebrates of the swamp forest are quite similar to those of the swamp forests considered above. Leafhoppers, spittlebugs, planthoppers, plantlice, and leaf beetles are among the abundant herbivores. Among the important predators are long-legged flies, spiders, fireflies, and rove beetles. Springtails, midges, and humpbacked flies are among the important scavengers. Braconids and ichneumon wasps are among the important parasites. Nor do the families present in abundance in Pinhook Bog, though they are fewer in number, fall into a difference pattern than that seen regularly in previously described communities. Leafhoppers, spittlebugs, and moth families are the abundant herbivores, long-legged flies and spiders the abundant predators, midges the abundant scavengers, and braconids and ichneumon wasps the abundant parasites. The invertebrates taken from the marsh do not fit well into any pattern other than that all the families present in four of six sample years are aquatic in at least some stage of their life cycle.

Vertebrate Animals of the National Lakeshore

Plants and invertebrate animals have been treated above on a community basis. To study with any thoroughness the vertebrates associated with each of the plant communities considered would require several kinds of sampling, each appropriate for different kinds of animals, over several seasons. This was not attempted for this report. Vertebrates will be considered rather on the basis of published records and interviews with Indiana authorities on various groups. In view of the infrequency with which certain forms are collected which are known to be present in given communities, this procedure is likely to provide more useful data than anything other than a very intensive sampling program. It has been thought that the most efficient way of presenting this information is in the form of annotated tables. The following items are included in these tables:

1) Common names. The common names are those used by Minton (1972), Mumford (1969), and the American Ornithologists' Union Check-List (1957) as amended (1973). If the scientific names are desired they may be obtained from these references.

2) Abundance. Different terms and numbers of classes have been used to indicate estimates of the abundance of organisms in an area. Used here are four abundance classes: a) rare, b) uncommon, c) common, and d) abundant. Rare is defined as very seldom encountered and abundant is defined as regularly observed in considerable number in the appropriate

habitats. These are obviously subjective evaluations, but are much more valuable than simple notations of presence or absence.

3) Habitat. Notations regarding habitat are taken from Minton (1972) for the amphibians and reptiles, Smith (1958) for the birds, and Mumford (1969) for the mammals. Minton (1972) and Mumford (1969) provide many further details which could not be included and they should be consulted for further information.

In addition to these annotated tables there are tables in which data obtained by various groups relative to vertebrates in the dunes area are brought together. In the case of the birds they are data collected in various counts over the years. In the case of amphibians, reptiles, and mammals they are data gathered by Ecological Services of Texas Instruments Incorporated. This group has been collecting and observing vertebrates in the vicinity of the Bailly generating station since 1974. Their sampling reported here was done in eight different community types. The names they use for these communities and the alternate names we have used above and use in the legends are as follows: 1) beachgrass = young foredune; 2) foredune = stable foredune; 3) immature oak forest = black oak forest; 4) Cowles Bog--wooded = black oak/swamp forest (their transect includes both the dry black oak forest and the swamp forest north and west of Cowles Bog); 5) Cowles Bog--open = marsh; 6) maple forest = red maple swamp forest; 7) emergent macrophyte community = pond #2; 8) transmission corridor (this is obviously not a natural community, but suitable habitat is provided for a variety of vertebrates; it is essentially an old field community). The numbers in these tables indicate the total number of individuals collected and observed during the course of the six years of study. In the case of amphibians note is made of chorus activity as well as numbers collected and observed; such choruses typically represent a fair number of individuals. The presence of mammals in a community can often be recognized by signs such as tracks or scat; such signs are noted in communities where no individuals were recognized.

Amphibians and Reptiles

The distribution, habitats, and habits of the amphibians and reptiles of Indiana have recently been thoroughly reviewed by Minton (1972). Dr. Minton graciously spent the better part of a day discussing with the author of this chapter his collection records, the likelihood of the occurrence in the dunes area of species for which there are no collection records, and habitat preferences. Many of these comments are included in the tables. I acknowledge with gratitude this assistance in the preparation of this section. Information relative to the amphibians of the dunes area is presented in Table 3-128, that regarding the reptiles in Table 3-129.

Table 3-128. An annotated list of amphibians known to occur, or possibly to occur, in the Indiana dunes area.

Common name	Abundance	Habitat
Blue-spotted Salamander	common	moist woods with sandy soil
Tremblay's Salamander	uncommon	woods bordering lakes or enclosing ponds
Spotted Salamander	uncommon	undisturbed woods, temporary ponds
Eastern Tiger Salamander	uncommon	near ponds, bogs, and marshes in both grasslands and woods
Marbled Salamander	rare	woods and wooded dunes
Central Newt	uncommon	woods with ponds or marshes
Four-toed Salamander	rare	swamp forests, bogs (It has not been collected in the National Lakeshore but can be expected in Pinhook bog.)
Slimy Salamander		woods (A specimen in the University of Illinois collection is labelled "Porter Co.," but this may be in error since this quite far north of its usual range.)
Redbacked Salamander	abundant	moist woods (Both striped and unstriped color phases are found in the National Lakeshore.)
Two-lined Salamander		near spring fed streams (There are no records from Lake, Porter, or LaPorte counties, but it should be looked for in streams since it has been reported for Berrien Co., Mich.)
Western Lesser Siren		in quiet water with mucky bottom (A Porter Co. record is from Hebron; probably not present in dunes area, but may be found in drainage ditches.)
American Toad	uncommon	grasslands and sparse woods
Fowler's Toad	abundant	open woods and clearings with sandy soil
Cricket Frog	common	shores of ponds and streams, quiet water in the open
Western Chorus Frog	uncommon	wetlands of all kinds
Spring Peeper	common	swamps and moist woods with ponds
Eastern Gray Treefrog	common	moist woods
Green Frog	abundant	ponds and streams, swamps
Bullfrog	common	ponds and streams, marshes, where there is permanent water
Northern Leopard Frog	common	ponds and streams, marshes, bogs
Pickerel Frog		clear streams, wet meadows, bogs (There is no authenticated record from Lake, Porter, or LaPorte counties, but it could well be found, especially in the bogs.)
Wood Frog	common	moist woods, near lakes and swamps

Table 3-129. An annotated list of reptiles known to occur, or possibly to occur, in the Indiana dunes area.

Common name	Abundance	Habitat
Common Snapping Turtle	uncommon	ponds and streams
Musk Turtle		ponds and streams with a soft bottom
	(Though there is no record for the dunes area this species should be found here commonly to uncommonly.)	
Spotted Turtle	rare	in clean, shallow water surrounded by undisturbed marshes and woods
	(Though this species has been collected at Dune Acres, Wilson, and Mineral Springs, its population in the state is declining rapidly and its status in the dunes area is therefore questionable.)	
Blanding's Turtle	rare	in quiet, shallow water surrounded by grasslands
	(Though less rare than the previous species, populations of this species too are declining rapidly and its survival in the state is questionable.)	
Eastern Box Turtle	uncommon	woods, suburbs
Map Turtle		lakes and large streams with a soft bottom
	(There is no record for the dunes area, but it could be present in Long Lake.)	
Midland Painted Turtle	abundant	ponds and streams, marshes, bogs
Red-eared Turtle		ponds and streams, swamps
	(There is no record for the dunes area, but it is possible that it could be found.)	
Eastern Spiny Softshell		lakes and large streams, especially those with sand or silt bottom
	(Though there is no record for the dunes area, this species is probably present here.)	
Glass "Snake"	rare	dunes, grasslands
Sixlined Racerunner	abundant	dry, open places with sandy or loose soil
Five-lined Skink		woods with sparse or moderate canopy
	(Though there is no record for the dunes area, this species is probably present here.)	
Banded Watersnake	abundant	ponds and streams
Queen Snake		ponds and streams
	(Though there is a record from Valparaiso, this species is probably not present in the dunes area.)	

Table 3-129 continued.

Common name	Abundance	Habitat
Kirtland's Snake	uncommon	urban and suburban areas, wetlands
Midland Brown Snake	common	grasslands, suburbs
Northern Redbellied Snake		dry woods, suburbs (Though there is no record from the dunes area, this species is common in the Chicago suburbs and could well be found here. A record from Gary is questionable.)
Chicago Garter Snake	abundant	damp grasslands, marshes, bogs
Plains Garter Snake	common	grasslands, suburbs
Butler's Garter Snake		moist grasslands, marshes, lake margins (This is one of the rarest snakes in Indiana and there are few records of it, but its presence in the dunes area is a possibility.)
Western Ribbon Snake	rare	grasslands, with sandy soil, near water (Though there are records from the dunes area this species is declining in number and its current status here is questionable.)
Blue Racer	uncommon	dry open woods, thickets, grasslands with sandy soil
Black Rat Snake		woods, bogs, suburban woods (There is no record for the dunes area but it should be found here.)
Western Fox Snake	uncommon	grasslands, sandy oak scrub
Eastern Milk Snake	uncommon	woods, grasslands, farms, suburbs
Western Smooth Green Snake	uncommon	moist grasslands (There is a specimen from the Indiana Dunes State Park at the University of Illinois; it is common in vacant lots in Chicago, and a specimen was seen in the Hoosier Prairie in 1972.)
Northern Ringneck Snake	rare	moist, shaded woods (There is a record from the trash pile at the edge of the state park and it should be looked for elsewhere.)
Eastern Hognose Snake	common	dry, open places, especially those with sandy soils
Eastern Massasauga	uncommon	rank grasslands, in undergrowth near lakes and marshes, swamps, bogs

It should be noted that two species listed in these tables, the Spotted Turtle and Blanding's Turtle, are in danger of being lost from Indiana.

In Table 3-130 are given the counts of amphibians and reptiles obtained by the Texas Instruments team during six years of study in the eight sample locations indicated. It may be noted that they have reported 11 of the 20 amphibians and 11 of the 28 reptiles which are known or can be expected to occur in the Indiana dunes area.

Birds

The Indiana dunes have been a favorite place for birders and bird-watching for many decades, not only for local residents but also for persons living in Chicago and far beyond. Unusual sightings have been regularly recorded in Audubon Field Notes and Indiana Audubon Quarterly. And in December of 1949 much of the dunes area began to be included in the well-known Christmas bird count. Though named the Michigan City count , the center of the 15 mile diameter circle was at the corner of U.S. 12 and State Park Road, the location of the current Visitor Center. But for years the only attempt to compile and annotate a list of the birds of the Indiana dunes was that of Eifrig (1918).

In 1975, a listing of the birds of the Indiana Dunes National Lakeshore was prepared by the Scientific Research Committee of the Chicago Audubon Society under the direction of Dr. Robert C. Tweit. It lists all birds observed there with any regularity, including nesting birds, migrants, winter residents, and casuals. This list has undergone two revisions, one in 1977 and one in 1980. The 1980 edition constitutes Table 3-131.

Lists such as this are based on a variety of data. For one thing there are various kinds of counts; these will be considered in detail below. But in addition there are individuals who have kept records over the years of birds they have observed in the dunes area; their names are given in the several editions of the list and their contributions acknowledged.

The best known of the counts is the Christmas count. On this count permanent residents and winter residents are recorded. The Michigan City Christmas count, with the center of its circle 15 miles in diameter at the present Visitor Center of the National Lakeshore, was conducted from 1949 to 1965 except in 1962; this count did not include Pinhook Bog. In 1972, the Indiana Dunes National Lakeshore count was initiated and has continued each year since. The center of its 15 mile circle is 1.9 miles south and 1.5 miles east of the Visitor Center. The eastern two-thirds of the National Lakeshore are included in this circle: Bailly Unit (except for a small part west of Indiana 149), Cowles Unit, State Park Unit, East Unit, Blue Heron Rookery Unit, and Pinhook Bog Unit. The data gathered in these Christmas counts are presented in Table 3-132.

Table 3-130. Counts of amphibians and reptiles collected and observed in six years by Ecological Services of Texas Instruments Incorporated at eight sample locations near Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Blue-spotted Salamander				2				
Redbacked Salamander				6				
American Toad	3			3		4	2	9
Fowler's Toad	1			7	1			2
Cricket Frog				ch	ch		ch	
Spring Peeper			1	8,ch	3,ch	5,ch	ch	
Eastern Gray Treefrog			1	1,ch	ch	2,ch	ch	4
Green Frog	2			223	121	8	130	35
Bullfrog				35	2,ch	1	12	
Northern Leopard Frog					4		2	3
Wood Frog				24,ch				
Common Snapping Turtle							3	
Eastern Box Turtle				2				
Midland Painted Turtle				2	5	1	48	
Glass "Snake"		1						1
Sixlined Racerunner	1	7	2					
Banded Watersnake				2	2		10	
Midland Brown Snake						1		
Chicago Garter Snake				7	1	1	2	3
Blue Racer			1	2	1			2
Western Smooth Green Snake		1						
Eastern Hognose Snake	2						1	1

ch = chorus activity

(1) young foredune
(2) stable foredune
(3) black oak forest
(4) black oak/swamp forest
(5) Cowles marsh
(6) red maple swamp forest
(7) pond #2
(8) transmission corridor

Table 3-131 Birds of the Indiana Dunes

INDIANA DUNES

National Lakeshore

Chesterton IN 46301



Indiana Dunes National Lakeshore preserves a 12,000 acre patchwork area dominated by huge sand dunes. Some are covered by deciduous woods while the ones closest to the lake are grass-covered or bare and wind-blown. Behind them lie marshes and wooded swamps with occasional ponds. The Little Calumet River drains the farms and woods further south. This varying habitat includes the northern edge of the range of many birds as well as several bogs representative of cooler climes. The area covered by this list; bounded by Michigan City and Westville on the east, US 6 on the south, and Indiana 51 and the end of the Lakeshore at Miller Lagoon on the west; provides regular resting, nesting, and wintering areas for at least 265 species of birds.

The symbols used in the list are defined below.

S-Spring (March-May) F-Fall (Sept.-Nov.)
S-Summer (June-August) W-Winter (Dec.-Feb.)

Migrant birds listed as present in spring and fall may only be present during parts of these seasons. For instance, May and September are peak months for many warblers while water birds pass through in March and November.

a-abundant-almost always seen or heard in habitat
c-common-often seen or heard in habitat
u-uncommon-sometimes seen or heard in habitat
r-rare-at least one individual present
x-accidental-not present every year
i-irregular-abundance varies widely
*-species known to breed in the Lakeshore

The following specific locations are suggested as typical of the habitat types mentioned.

l-Lake, b-Beach - The easiest access points to the Lake Michigan beach are the Indiana Dunes State Park, end of Indiana 49 (admission charge); the West Beach unit; and State Park Road and Central Avenue in Beverly Shores.

m-Marsh - Cowles Bog is northwest of the Dune Acres South Shore Station, turn north from US 12. Another marsh surrounds Long Lake at West Beach.

w-Woods - Trail 9 and the south side of the Trail 10 Loop in the State Park cross wooded dunes. The trail behind Lakeshore headquarters, the trail to Mt. Baldy, Ly-Co-Ki-We horsetrail, and the trails at Bailly homestead also traverse deciduous woods.

f-Fields - Open areas along the Calumet bicycle trail, Chellburg farm, and cultivated fields.

p-Ponds - Long Lake at West Beach, farm ponds, highway borrow pits and flooded fields.

s-Wooded swamps - Trail 2 in the State Park and many areas along the Little Calumet River.

d-Dunes - Mt. Baldy at the east end of Beverly Shores and the grassy hills just behind the beach in the State Park and at West Beach.

h-Harbor - Michigan City Harbor, Trail Creek, and the Port of Indiana.

c-Conifers, we-Wood edges - Scattered throughout the area.

Where no habitat is given, the species is usually seen in flight.

The names used are those of the 5th Edition of the A.O.U. Checklist, with corrections from the 33rd Supplement.

Please leave any corrections, additions, suggestions, or interesting observations at the Lakeshore headquarters. They are welcomed.

Prepared for the Lakeshore by the Scientific Research Committee of the Chicago Audubon Society, William DeBaets, coordinator. We wish to thank Dr. Kenneth Brock, Dr. Robert Tweit, Mr. Charles Clark, Mr. Peter Grube, and Ms. Joy Underborn for their valuable contributions.

Table 1-131 Continued

	S	S	F	W	HABITAT
Common Loon	u	x	u	r	l
Red-throated Loon	r		r		l
Red-necked Grebe			x		l
Horned Grebe	c		c	r	l,h
Eared Grebe			x	x	l,h
Western Grebe			x	x	l,h
*Pied-billed Grebe	c	c	c	r	m,p
Double-crested Cormorant	r		u	x	l
*Great Blue Heron	c	c	c	x	m
*Green Heron	c	c	c		m,p
Little Blue Heron	r	r	r		m
Cattle Egret	r		r		f,p
Great Egret	r	r	r		m
Black-crowned Night Heron	u	u	u		m
Yellow-crowned Night Heron	r	r	r		m
*Least Bittern	u	u	u		m
American Bittern	u	r	r		m
Mute Swan	r		r		l,p
Whistling Swan			r	x	l,p
*Canada Goose	c	c	c	u	l,m,p
Brant			x	x	l,p
Snow Goose			u	x	
*Mallard	c	c	c	c	m,h,p
Black Duck	c		c	u	l,m
Gadwall	u		u	r	m
Common Pintail	u		u	r	m
Green-winged Teal	u		u	r	m
*Blue-winged Teal	c	c	c		m
American Wigeon	c		c	r	m
Northern Shoveler	c		c	x	m,p
*Wood Duck	c	u	c	r	s
Redhead	c		c	r	l,h,p
Ring-necked Duck	c		c	r	m,h,p
Canvasback	u		u	r	m,h
Greater Scaup	u		u	u	l,h,p
Lesser Scaup	c		c	u	l,h,p
Common Goldeneye	c		c	c	l,h
Bufflehead	c		c	a	l,h
Oldsquaw				r	l
Harlequin Duck				r	h
White-winged Scoter	r		r	r	l
Surf Scoter	x		r	r	l
Black Scoter	x		r	r	l
Ruddy Duck	u		u	r	l,h,p
Hooded Merganser	u		u	r	m
Common Merganser	u		u	c	l
Red-Breasted Merganser	c		c	u	l,p
Turkey Vulture	c	c	u		
Sharp-shinned Hawk	u		u	r	
Cooper's Hawk	r		r	r	
*Red-tailed Hawk	c	c	c	c	
*Red-shouldered Hawk	u	r	u	r	
*Broad-winged Hawk	u	r	u		
Rough-legged Hawk	u		u	u	
Golden Eagle	x				
Bald Eagle	r		r	x	
Northern Harrier	u	r	u	r	
Osprey	r		r		
Peregrine Falcon			r		
Merlin	r		r	x	

	S	S	F	W	HABITAT
*American Kestrel	c	u	c	u	
*Common Bobwhite	c	c	u	u	w,f
*Ring-necked Pheasant	c	u	u	u	f
Sandhill Crane	r		r		
*King Rail	r	r	r		m
*Virginia Rail	c	u	u	r	m
*Sora	c	c	c		m
Yellow Rail	r				m
*Common Gallinule	c	c	c		m
*American Coot	a	c	a	r	m,p,h
American Avocet	x	r			b
Piping Plover		r	r		b
Semipalmated Plover	u	u	u		b,p
*Killdeer	c	c	c	r	m,d
Lesser Golden Plover	u		x		f,p
Black-bellied Plover	u	u	u		b,p
Marbled Godwit		x			b,f
Whimbrel	r	x	x		b
Ruddy Turnstone	u	u	c		b,h
*American Woodcock	c	c	u		s,w
Common Snipe	c	u	c	r	m,p
Upland Sandpiper	r				f
*Spotted Sandpiper	c	c	c		m,s
Solitary Sandpiper	c	c	c		m
Willet	r	u	r		b
Greater Yellowlegs	u	r	r		m,p
Lesser Yellowlegs	c	u	u		m,p
Red Knot		r	r		b
Purple Sandpiper				r	h
Pectoral Sandpiper	c	u	c		m,p
Baird's Sandpiper			r		b,p
Least Sandpiper	u	u	u		b,p
Dunlin	u		u		b,p
Short-billed Dowitcher		r	r		p
Semipalmated Sandpiper	c	u	c		b,h,p
Sanderling	c	c	c	x	b
Buff-breasted Sandpiper			x		b,p,f
Red Phalarope			x		l,h
Wilson's Phalarope			x		p
Parasitic Jaeger			r		l
Pomarine Jaeger			x	x	l
Glaucous Gull				r	l,b,h
Greater Black-backed Gull				x	b
Herring Gull	a	u	a	c	l,b,h
Thayer's Gull				r	l,b,h
Ring-billed Gull	a	c	a	u	l,b,h
Laughing Gull	x		x		l,b,h
Franklin's Gull		r	r		l,b,h
Bonaparte's Gull	c	u	c	r	l,b,h
Little Gull			r	r	l,b,h
Black-legged Kittiwake			x	x	l,b,h
Sabine's Gull			x		l,b,h
Forster's Tern	c	u	u		l,b,h
Common Tern	c	u	c		l,b,h
Caspian Tern	u	c	c		l,b,h
*Black Tern	c	c	c		m,l
*Rock Dove	u	u	c	u	urban
*Mourning Dove	c	c	c	c	w,f
*Yellow-billed Cuckoo	c	c	c		w
*Black-billed Cuckoo	u	u	u		w

Table 1-131 Continued

	S	S	F	W	HABITAT
*Screech Owl	u	u	u	u	w
*Great Horned Owl	u	u	u	u	w
Snowy Owl			r	r	d
*Barred Owl	u	u	u	u	s
Long-eared Owl				r	c
Short-eared Owl	r		r		d
Saw-whet Owl			x		we
*Whip-poor-will	c	u	u		w
*Common Nighthawk	u	u	c		
*Chimney Swift	c	c	c		
*Ruby-throated Hummingbird	c	u	c		w
*Belted Kingfisher	c	c	c	u	m,p
*Common Flicker	c	c	c	r	w
*Red-bellied Woodpecker	c	u	c	u	w
*Red-headed Woodpecker	c	c	c	u	w
Yellow-bellied Sapsucker	c		c	r	w
*Hairy Woodpecker	u	u	u	u	w
*Downy Woodpecker	a	a	a	a	w,we
*Eastern Kingbird	c	c	u		f,m
*Great-crested Flycatcher	c	c	c		w
*Eastern Phoebe	c	r	c		f,w,we
Yellow-bellied Flycatcher	u		u		w
*Acadian Flycatcher	c	c	c		w
Alder Flycatcher	u	u	u		m
*Willow Flycatcher	c	c			m
*Least Flycatcher	c	u	u		w,we
Olive-sided Flycatcher	u		u		w,s
*Eastern Pewee	c	c	c		w
*Horned Lark	c	u	c	u	f,b
*Tree Swallow	c	c	c		m
*Bank Swallow	c	c	c		b,d
Rough-winged Swallow	c	u	c		m
*Barn Swallow	c	c	c		f
Cliff Swallow	r		r		f
*Purple Martin	c	c	c		
*Blue Jay	a	a	a	a	w
*Common Crow	c	c	c	c	all
*Black-capped Chickadee	c	c	c	c	w
*Tufted Titmouse	c	c	c	c	w
*White-breasted Nuthatch	c	c	c	c	w
Red-breasted Nuthatch	u		u	u	c
Brown Creeper	c		c	u	w
*House Wren	c	c	c		w
Winter Wren	u	r	u	r	w
Carolina Wren	r	r	r	r	w
*Marsh Wren	a	c	c		m
*Sedge Wren	u	u	u		m
Northern Mockingbird	r		r	x	d,m
*Gray Catbird	c	c	c		we
*Brown Thrasher	c	c	c	r	we
*American Robin	a	a	a	r	w,f
*Wood Thrush	c	c	u		w
Hermit Thrush	c		c	r	w
Swainson's Thrush	c		c		w
Gray-cheeked Thrush	c		c		w
*Veery	c	c	c		w
*Eastern Bluebird	u	r	u	r	f,we
*Blue-gray Gnatcatcher	u	u	u		w
Golden-crowned Kinglet	c		c	r	w
Ruby-crowned Kinglet	c		c	x	w

	S	S	F	W	HABITAT
Water Pipit	r		r		b,f,p
*Cedar Waxwing	c	u	c	u	w,m
Northern Shrike				r	we,m
*European Starling	a	a	a	a	all
*White-eyed Vireo	u	r	r		w
*Yellow-throated Vireo	c	c	u		w
Solitary Vireo	c		c		w
*Red-eyed Vireo	a	a	c		w
Philadelphia Vireo	u		u		w
*Warbling Vireo	c	c	u		we
*Black and White Warbler	c	u	c		w
Prothonotary Warbler	r				s
Worm-eating Warbler	r				w
*Golden-winged Warbler	u	u	u		we
*Blue-winged Warbler	c	c	c		we
Tennessee Warbler	c		c		w
Orange-crowned Warbler	u		u		w
Nashville Warbler	c		c		w
Northern Parula Warbler	u		r		w
*Yellow Warbler	c	c	r		we,m
Magnolia Warbler	c		c		w
Cape May Warbler	c		c		w
Black-throated Blue Warbler	u		u		w
Yellow-rumped Warbler	a		a	x	w,m
Black-throated Green Warbler	c		c		w
*Cerulean Warbler	c	c			w
Blackburnian Warbler	c		c		w
*Chestnut-sided Warbler	c	r	c		w,we
Bay-breasted Warbler	c		c		w
Blackpoll Warbler	c		c		w
*Prairie Warbler	u	u			d
Palm Warbler	c		c		we,m
*Ovenbird	c	c	u		w
Northern Waterthrush	c		c		we,m
*Louisiana Waterthrush	u	u			s
Kentucky Warbler	r	r			s
Connecticut Warbler	r				we
*Mourning Warbler	u	r	u		we
*Common Yellowthroat	a	a	a		m
*Yellow-breasted Chat	u	u	r		m,we
*Hooded Warbler	r	u			s
Wilson's Warbler	c		c		w
*Canada Warbler	c	r	c		w
*American Redstart	c	c	c		w
*House Sparrow	a	a	a	a	urban
*Bobolink	c	u	u		f
*Eastern Meadowlark	c	c	c		f
Western Meadowlark	r				f
Yellow-headed Blackbird				x	m
*Red-winged Blackbird	a	a	a	r	m
Orchard Oriole	r	r			we
*Northern Oriole	c	c	c		w
Rusty Blackbird	c		c		s
Brewer's Blackbird			x	x	f
*Common Grackle	a	a	a	r	m,f
*Brown-headed Cowbird	c	c	u	r	w
*Scarlet Tanager	c	c	u		w
*Cardinal	c	c	c	c	we
*Rose-breasted Grosbeak	c	c	c		w
*Indigo Bunting	a	a	c		we

	S	S	F	W	HABITAT
Dickcissel	i	i	i		f
Evening Grosbeak	i			i	c,we
Purple Finch	c		c	u	w
Pine Grosbeak				x	w,c
Common Redpoll				i	we,d
Pine Siskin	i		i	i	w,c
*American Goldfinch	c	c	c	c	we,f
Red Crossbill				i	c
White-winged Crossbill				i	c
*Rufous-sided Towhee	c	c	c	r	we
*Savannah Sparrow	u		u		f,d
LeConte's Sparrow			r		m
*Vesper Sparrow	u	u	u		f,d
Dark-eyed Junco	c		c	a	we
Tree Sparrow	c		c	a	we,f,d
*Chipping Sparrow	c	c	c	r	we,f,d
*Field Sparrow	c	c	c	r	f,d,m
Harris' Sparrow			r		m
White-crowned Sparrow	c		c	r	we
White-throated Sparrow	a		a	r	we
Fox Sparrow	c		c	x	we
Lincoln's Sparrow	c		u		w
*Swamp Sparrow	c	c	c	u	m
*Song Sparrow	a	a	a	u	m,we
Lapland Longspur			r		b
Snow Bunting			u	u	f,b

Table 3-132 A summary of Christmas bird count data for the dunes area: Michigan City counts, 1949-1962: Indiana Dunes National Lakeshore counts, 1972-1979.

	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1963	1964
COMMON LOON				1											
RED-NECKED GREBE															
HORNED GREBE				3	10	15	6	95	6		4		1		
EARED GREBE															
WESTERN GREBE					1			1							
PIED-BIL. GREBE				1				1						1	
D-CR. CORMORANT						1		1							
GT-BLUE HERON							1	1							
WHISTLING SWAN															
CANADA GOOSE															
BLUE GOOSE															
MALLARD		8		8	185	27	62	14	127	107	28	120	82	212	123
BLACK DUCK		26	35	14	250	65	45	16	50	95	12	225	100	103	148
WOOD DUCK															
GADWALL													1		1
AM. WIGEON						2									
PINTAIL				2	7	1	3			2		5		1	
GRN-WNG TEAL										1					
SHOVELER				5											
REDHEAD				8	6		9	2				1		3	1
RING-NECK DUCK															1
CANVASBACK			1	7	14		2			2		2			7
GR. SCAUP					6	1		3		4		10	2	3	
LESSER SCAUP	1		20	2	230	200	305	1	16	67	10	33	110	15	28
SCAUP SPECIES															
COM. GOLDENEYE	210	175	367	12	280	475	645	330	28	78	53	141	200	150	52
BUFFLEHEAD	80	40	325	108	512	375	360	220	60	185	60	175	150	55	204
OLDSQUAW	6	1	1000	250	546	3000	31534	2046	750	1	25	10	25	1	3
HARLEQUIN DUCK															
WH-WING. SCOTER			1	1		6									
SURF SCOTER							1	1							
BLACK SCOTER															
RUDDY DUCK						1	1					2			
HOODED MERGANSER				4	4	4	1	1	3						
COM. MERGANSER	19	7	850	10	353	410	967	18	250	245	35	106	200	40	5
RED-BR. MERGANSER	2	5	8	12	114	17	6	5	28	4	3	8	56	1	3
GOSHAWK															
SHARP-SH HAWK				1			1								1
COOPER'S HAWK					1	1	1		1						
RED-TAILED HAWK				1	2	3	7		2	1	1	3	2		2
RED-SH HAWK				1	1		5	2	2	2	2	2	1		2
ROUGH-LEG HAWK															1
EAGLE (SPECIES)															2
MARSH HAWK		1		6	2	3	1	2	1	2					
MERLIN															
AM. KESTREL			1	4	6	7	2	11	3			2			3
BOBWHITE					23	21	13	17	14	2	2	23	24	2	3
R.N. PHEASANT	1	1	1	2	6	8	5	1	1						
VIRGINIA RAIL															1
AM. COOT				2		2	3								
KILLDEER								2	1				1		
SANDERLING															1
AM. WOODCOCK															
COM. SNIPE						2									
RED PHALAROPE					1										
POMARINE JAEGER						1									
ICELAND GULL															
GREAT BL-BACK GULL															
HERRING GULL	53	50	121	520	623	780	1094	3400	170	40	225	605	37	87	526
RING-BILLED GULL	400	2	21	155	203	265	355	275	355	30	34	114	30	124	66
BONAPARTE'S GULL	650			75	21	650	215	685	25						
LITTLE GULL						2	1	1							
BL-LEG KITTIWAKE					1										
ROCK DOVE															
MOURNING DOVE	4			1	24	3	30	11	8	8	4	3	3		2
SCREECH OWL															
GT-HORNED OWL							1	1	1						1
SNOWY OWL															
BARRED OWL															
LONG-EARED OWL							1		2	1					1
SHORT-EAR OWL															
BELT. KINGFISHER				2	3	3	3	2	1	1	1	1			
COM. FLICKER		1			1		2		6	1	1	4	4		4
RED-BEL WOODPECKER			1				2	1	2	1	2	2	1		2
RED-HD WOODPECKER						65	2		6	18	2	2			10
Y.B. SAPSUCKER		1	4		4	2	5	5	6	6	6	2	5		
HAIRY WOODPECKER	2	1		11	3	2	2		3	6	13	2	1		
DOWNY WOODPECKER	10	4	10	26	20	34	34	15	16	16	21	24	20	21	14
HORNED LARK							22		30	7					5
BLUE JAY	48	22	45	25	74	227	180	49	114	72	67	28	76	46	103
COM. CROW	24	4	4	24	85	85	172	231	192	200	304	22	110	46	30
BL-CAP CHICKADEE	42	17	25	42	17	51	54	8	43	29	47	28	35	42	14
TUFTED TITMOUSE	20	1	8	10	30	21	37	19	35	31	36	21	24	22	14
WH-BR NUTHATCH	11	2	9	12	13	16	19	8	20	10	15	11	24	25	14
RED-BR NUTHATCH							1		4				1	4	1
BROWN CREEPER					2	2	1								
WINTER WREN					2	2									
CAROLINA WREN				1	1	2		1	2		2				
L.B. MARSH WREN															
WREN SPECIES				1											
MOCKINGBIRD									2		1				
CATBIRD					1										
BRN. THRASHER							3								
ROBIN	1				3	6		3	4	4	1	1			
HERMIT THRUSH		1													
E. BLUEBIRD															
GOLD-CRN KINGLET							1								
RUBY-CRN KINGLET															
CEDAR WAXWING									10	8	1				
NORTHERN SHRIKE				1			16								5
STARLING	4	1	19	39	329	600	1755	58	700	635	600	163	240	314	154
YEL-RUMP WARBLER							2								
HOUSE SPARROW	48	1	200	46	1202	300	1500	232	600	290	550	230	640	615	300
YEL-HD BLACKBIRD															
E. MEADOWLARK															
RED-WING BLACKBIRD	5		42	45	204	836	10063	36	106	60	52	169	178	47	1990
BREWER'S BLACKBIRD															
RUSTY BLACKBIRD				48	7	1	32		1		1		2		
COM. GRACKLE						2	1000								
BRN-HD COWBIRD							1400					1	1		
CARDINAL	34	12	12	31	37	45	82	47	34	24	41	56	66	31	10
EVENING GROSBEAK			2	1		108	24		22	1	26		451	41	14
PURPLE FINCH	37		49	4	49	26	5	19	26	12	5	68	2	25	37
PINE GROSBEAK			7					1						1	
COM. REDPOLL				24		21		22	2	50					
PINE SISKIN						3			4	2					
AM. GOLDFINCH	8	2	2	25	61	16	67	36	68	95	85	13	29	26	79
RED CROSSBILL															
WH-WING CROSSBILL															
SAVANNAH SPARROW															
R.S. TOWHEE				2		6	1	2	1						1
DARK-EYED JUNCO	63	27	20	132	445	95	346	153	212	350	200	169	306	83	264
OREGON JUNCO											1				
TREE SPARROW	17	3	22	302	735	233	317	162	470	537	415	174	1020	499	289
CHIPPING SPARROW															
FIELD SPARROW					6		1	1	2		5	2	2		1
HARRIS' SPARROW											1				
WH-CRN SPARROW					10			4		8	5	20		27	22
WH-TH SPARROW					4		1						2		
FOX SPARROW														1	1
SWAMP SPARROW				23	7		2			4	2			3	2
SONG SPARROW	2	2	6	22	19	10	14	21	9	38	52	148	50	33	26
LAPLAND LONGSPUR						5		3	1		2		5	20	1
SNOW BUNTING			3			37	1	2	18	25			2		

Table 3-132 Continued

	1965	1972	1973	1974	1975	1976	1977	1978	1979
COMMON LOON					1			2	
RED-NECKED GREBE				2					
HORNED GREBE				3	2	1			3
EARED GREBE									
WESTERN GREBE									
PIED-BIL. GREBE		5	3		1				1
D-CR. CORMORANT									
GT-BLUE HERON									
WHISTLING SWAN	1						1		
CANADA GOOSE			37	82	32	80	76	143	250
BLUE GOOSE	3							1	
MALLARD	220	37	155	231	317	498	400	531	288
BLACK DUCK	160		7	56	24	58	13	28	22
WOOD DUCK					1		2		
GADWALL	8				1	1		5	7
AM. WIGEON			5						
PINTAIL	4						18		2
GRN-WNG TEAL									
SHOVELER	1								
REDHEAD	2			2		5			10
RING-NECK DUCK	15				6		1		
CANVASBACK	2					2			
GR. SCAUP	10					12	1	57	
LESSER SCAUP	17	31				21	15	22	20
SCAUP SPECIES	22				32				
COM. GOLDENEYE	26	300	24	65	33	374	71	343	142
BUFFLEHEAD	25	50	88	123	117	330	182	450	191
OLDSQUAW	20				1				20
HARLEQUIN DUCK								2	
WHWING. SCOTER				3	26	2			2
SURF SCOTER						1			
BLACK SCOTER									
RUDDY DUCK	2						4		
HOODED MERGANSER		15		13	86	28	20	37	28
COM. MERGANSER				86	10	14	14	47	85
RED-BR. MERGANSER	2		2						
GOSHAWK									
SHARP-SH HAWK	1			1	2	2	2	3	2
COOPER'S HAWK						1			
RED-TAILED HAWK	4	12	18	26	17	20	21	14	3
RED-SH HAWK					1				
ROUGH-LEG HAWK		2	4	14	1	25	8	7	
EAGLE (SPECIES)									
MARSH HAWK		15		9		14	1		
MERLIN									
AM. KESTREL	4	12	25	25	25	20	2	12	
BOBWHITE		12	13	9	43	18	35		12
RING. PHEASANT	10	2		7	7	8	4	5	
VIRGINIA RAIL									
AM. COOT	1		2		15	10	4		
KILLDEER				2	5	1	3		
SANDERLING									
AM. WOODCOCK									
COM. SNIPE				2		3			
RED PHALAROPE									
POMARINE JAEGEN									
ICELAND GULL									
GREAT BL-BACK GULL									
HERRING GULL	1200	1500	140	320	608	275	459	1087	577
RING-BILLED GULL	600	700	47	197	340	38	171	243	117
BONAPARTE'S GULL			2		5			17	3
LITTLE GULL									
BL-LEG KITTIWAKE									
ROCK DOVE			400	162	156	395	233	181	42
MOUR. DOVE		71	119	92	233	204	177	116	42
SCREECH OWL					1	7	5	20	
GT-HORNED OWL					3	3	6	3	
SNOWY OWL									
BARRED OWL	2			2	1		2	2	5
LONG-EARED OWL				1					
SHORT-EAR OWL									
BELT. KINGFISHER	1		4	2		5	2	3	
COM. FLICKER			23	30				25	
RED-BEL WOODPECKER	8	21	27	38	38	44	54	33	25
RED-HD WOODPECKER	12	1	17	32	84	148	58	22	15
YLW SAPSUCKER	9		1		2				
HAIRY WOODPECKER	9	12	16	24	29	30	31	23	22
DOWNY WOODPECKER	20	46	71	84	100	95	94	125	90
HORNED LARK	1		26	7	6	20	5	12	5
BLUE JAY	76	24	341	327	321	557	345	327	145
COM. CROW	31	33	323	435	214	238	350	282	170
BL-CAP CHICKADEE	45	86	105	102	206	270	191	151	175
TUFTED TITMOUSE	34	128	124	130	197	185	142	132	100
WHBR NUTHATCH	1	51	63	131	127	130	112	113	100
RED-BR NUTHATCH	1	0	7	2	16	14	21	9	3
BROWN CREEPER			3	12	8	4	5	3	3
WINTER WREN				2		1			
CAROLINA WREN	1		1	2	6	1	2		
LAB. MARSH WREN									
WREN SPECIES									
MOCKINGBIRD									
CATBIRD									
BRN. THRASHER					1				
ROBIN		36	5	3	10	3	32	86	
WHPOOR WILL									
HERMIT THRUSH		1		1	1				
E. BLUEBIRD						1	2		
GOLD-CRN KINGLET			3	2	1	4	4	10	17
RUBY-CRN KINGLET									
CEDAR WAXWING			15	2	1	85	1	41	61
NORTHERN SHRIKE									
STARLING	352	55	450	770	619	612	871	3043	889
YEL-RUMP WARBLER							4	1	
HOUSE SPARROW	320	500	724	956	1447	1168	1179	710	584
YEL-HD BLACKBIRD			1	3		2			
E. MEADOWLARK								2	
RED-WING BLACKBIRD	61	1	3000	860	4	21	100	35	12
BREWER'S BLACKBIRD						1	3		
RUSTY BLACKBIRD	2								
COM. GRACKLE	1	2	10900	21	19	9	11	88	24
BRN-HD COWBIRD		0	1400	3	4	0	27	70	14
CARDINAL	30	107	215	180	270	205	104	209	101
EVENING GROSBEAK	70	88	4	91	154		374		
PURPLE FINCH	1	28	64	10	48	37	47	65	14
PINE GROSBEAK									7
COM REDPOLL	7	3			11	5	20	12	
PINE SISKIN		14	87	24	14	1	165	5	
AM. GOLDFINCH	25	129	218	274	215	329	282	298	411
RED CROSSBILL		7	1						
WHWING CROSSBILL	10						1		
SAVANNAH SPARROW	1								
H.S. TOWHEE					10			2	2
DARK-EYED JUNCO	185	463	654	431	1134	666	827	589	602
OREGON JUNCO									
TREE SPARROW	182	115	332	386	596	767	802	473	226
CHIPPING SPARROW			6	1	1	1			
FIELD SPARROW		1		35	50	20	10	38	2
HARRIS' SPARROW									
WHCRN SPARROW	2			7	15	11	6	6	1
WHTH SPARROW	1			3	7	21	1	6	1
FOX SPARROW									
SWAMP SPARROW			5	5	26	8	1	6	4
SONG SPARROW	28	23	35	28	105	36	35	24	10
LAPLAND LONGSPUR									1
SNOW BUNTING	11		31	17	74	64	555	82	115

A second type of count is the Big Day count. These counts are conducted at the height of migration in late spring and record permanent residents, late departing winter residents, summer residents, and transients. Indiana Dunes National Lakeshore Big Day counts have been conducted each year since 1976, and the data gathered in these counts are tabulated in Table 3-133. It should be noted that the area for these counts is much larger than that for the Christmas counts.

A third type of count is the breeding season bird census. These counts are conducted very late in the Spring or early in the summer and record permanent residents and summer residents, that is birds which breed in the area. Some of the birds listed on these counts, however, may simply be late migrants or wanderers. Therefore, one must interpret the records with care and can be certain that a given species is breeding in the area only when nests are found (and in many cases that is very difficult). These counts are perhaps the most valuable of the three in that they indicate the suitability of the habitat of a given area for the maintenance or enhancement of species populations. Breeding bird censuses were conducted in 1975 and 1976 in the 15 mile diameter circle established for the Indiana Dunes National Lakeshore Christmas counts and in 1977 in T 37 N, R 5 W and T 37 N, R 6 W (Tweit 1975, 1981). Particular attention was paid in these counts to the parts of the national lakeshore within their area. The data gathered in these counts are presented in Table 3-134.

In the list of birds of the Indiana Dunes National Lakeshore, Table 3-131, breeding birds are indicated with an asterisk. Data for this notation are from records of nesting kept by individuals from breeding bird census data, and there have been variations in this notation from one edition to the next as new records have become available to the compilers. In Table 3-135 is an annotated list of the birds listed in Table 3-131 as breeding plus several others which probably or possibly breed or are known to have bred recently in the dunes area. Valuable information concerning records, habitats, and abundance of Chicago area (including the Indiana dunes) birds is provided in booklets by Ford (1956) and Smith (1958). Smith's listing of habitats was used with few exceptions, but words or short phrases are used in the table rather than letter codes for ease in reading the table. These words and phrases, and their meaning following the dashes, are as follows:

a) Open water of Lake Michigan;
b) open water of ponds and streams -- other than Lake Michigan;
c) shores of Lake Michigan;
d) shores of ponds and streams -- other than Lake Michigan;
   open waters -- refers to a) and b)
   shores -- referrs to c) and d)
   Lake Michigan -- refers to a) and c)
   ponds and streams -- refers to b) and d)
e) marshes--grassy wetlands;
f) swamps -- wetlands dominated by trees;
g) grasslands -- grass covered dunes, prairie, open fields, pastures;

Table 3-133 A summary of Indiana Dunes National Lakeshore Big Bay bird count data.

	1976	1977	1978	1979	1980
Common Loon	2	2	1	-	16
Red-throated Loon	1	-	-	-	
Pied-billed Grebe	15	23	11	7	8
Great Blue Heron	11	6	20	14	32
Green Heron	20	16	33	19	37
Great Egret	3	-	-	2	-
Yellow-crowned Night Heron	1	-	-	-	-
Cattle Egret	-	-	1	-	-
Least Bittern	-	-	-	1	-
American Bittern	1	1	2	-	1
Mute Swan	-	-	-	-	2
Canada Goose	9	22	17	12	16
Snow Goose	-	-	-	-	1
Mallard	73	109	60	34	-
Gadwall	-	1	2	-	-
Green-winged Teal	-	3	-	-	2
Blue-winged Teal	73	87	28	12	14
Pintail	-	-	1	1	-
Northern Shoveler	1	3	-	3	-
Wood Duck	37	26	46	30	27
Ring-necked Duck	-	6	-	-	-
Greater Scaup	1	2	-	-	-
Lesser Scaup	2	6	3	1	
Common Goldeneye	1	-	-	-	-
Bufflehead	5	-	8	3	4
Surf Scoter	1	-	-	-	-
Ruddy Duck	3	-	-	-	2
Common Merganser	-	-	4	-	-
Red-breasted Merganser	7	9	4	17	14
Turkey Vulture	37	12	25	9	54
Sharp-shinned Hawk	2	1	-	-	13
Cooper's Hawk	1	-	1	-	-
Red-tailed Hawk	7	11	4	2	11
Red-shouldered Hawk	-	-	1	2	1
Broad-winged Hawk	5	1	4	-	8
Marsh Hawk	8	7	3	1	7
Osprey	1	1	2	-	2
Peregrine Falcon	-	-	1	-	-
Merlin	-	-	-	1	-
American Kestrel	26	4	2	1	6
Bobwhite	24	17	8	8	3
Ring-necked Pheasant	13	17	13	2	6
Sandhill Crane	-	-	1	-	-
King Rail	-	-	1	-	-
Virginia Rail	8	3	4	2	1
Sora	40	11	26	12	14
Common Gallinule	5	3	2	2	-
American Coot	323	404	42	33	52
Semipalmated Plover	1	5	13	8	25
Killdeer	63	46	38	15	42
Golden Plover	3	98	2	-	185

Table 3-133 continued

	1976	1977	1978	1979	1980
Ruddy Turnstone	-	-	4	1	-
American Woodcock	1	5	1	1	8
Common Snipe	3	9	-	-	5
Spotted Sandpiper	16	7	45	13	23
Solitary Sandpiper	13	14	10	1	14
Willet	-	-	1	-	-
Greater Yellowlegs	4	4	-	6	2
Lesser Yellowlegs	15	15	15	5	4
Pectoral Sandpiper	13	45	-	16	42
Least Sandpiper	7	6	15	13	41
Dunlin	9	12	20	301	10
Short-billed Dowitcher	-	-	3	-	-
Stilt Sandpiper	-	-	1	-	-
Semipalmated Sandpiper	1	2	6	-	16
Sanderling	-	11	-	-	-
Herring Gull	335	30	58	33	45
Ring-billed Bull	639	147	81	86	129
Laughing Gull	-	-	1	-	-
Bonaparte's Gull	100	1	2	-	2
Forster's Tern	9	9	3	32	15
Common Tern	129	4	67	622	150
Caspian Tern	1	1	-	2	2
Black Tern	2	4	28	23	-
Rock Dove	95	31	87	87	58
Mourning Dove	232	123	131	68	111
Yellow-billed Cuckoo	-	-	-	4	1
Black-billed Cuckoo	-	1	8	2	3
Screech Owl	7	1	2	-	2
Great-horned Owl	-	-	1	-	-
Barred Owl	2	3	1	1	2
Whip-poor-will	5	2	5	10	6
Common Nighthawk	-	5	83	21	5
Chimney Swift	79	23	54	84	60
Ruby-throated Hummingbird	3	-	8	5	1
Belted Kingfisher	13	3	5	7	9
Common Flicker	100	43	57	51	81
Pileated Woodpecker	-	-	-	-	1
Red-bellied Woodpecker	20	11	30	14	16
Red-headed Woodpecker	59	65	65	36	40
Yellow-bellied Sapsucker	7	-	1	3	3
Hairy Woodpecker	16	10	12	11	22
Downy Woodpecker	33	32	37	24	61
Eastern Kingbird	6	9	50	30	38
Great-crested Flycatcher	3	1	20	21	16
Eastern Phoebe	8	4	6	10	8
Yellow-bellied Flycatcher	-	-	3	-	-
Acadian Flycatcher	1	-	2	3	-
Alder Flycatcher	-	-	-	1	-
Willow Flycatcher	-	-	4	-	1
Least Flycatcher	2	-	7	9	15
Olive-sided Flycatcher	-	-	2	1	-
Eastern Wood Pewee	1	1	8	8	3
Horned Lark	4	12	4	10	4

Table 3-133 continued

	1976	1977	1978	1979	1980
Tree Swallow	213	446	143	193	170
Bank Swallow	64	84	43	49	1
Rough-winged Swallow	9	58	109	108	22
Barn Swallow	200	287	229	431	151
Cliff Swallow	2	2	-	-	2
Purple Martin	105	48	62	38	26
Blue Jay	358	88	173	162	247
Common Crow	89	67	95	99	87
Black-capped Chickadee	19	13	40	30	35
Tufted Titmouse	35	39	64	51	41
White-breasted Nuthatch	18	14	28	22	25
Red-breasted Nuthatch	21	8	16	1	-
Brown Creeper	2	2	3	1	1
House Wren	67	52	60	36	57
Winter Wren	2	-	1	3	-
Carolina Wren	2	-	-	1	-
Long-billed Marsh Wren	13	6	3	1	1
Short-billed Marsh Wren	2	4	2	-	3
Mockingbird	-	-	2	-	-
Gray Catbird	61	53	155	117	111
Brown Thrasher	64	49	84	44	63
Robin	391	210	215	218	665
Wood Thrush	39	34	53	44	39
Hermit Thrush	4	-	5	7	4
Swainson's Thrush	11	-	72	39	1
Gray-cheeked Thrush	7	2	22	21	-
Veery	4	5	32	12	24
Eastern Bluebird	3	-	-	-	-
Blue-gray Gnatcatcher	2	5	8	5	22
Golden-crowned Kinglet	-	-	2	-	3
Ruby-crowned Kinglet	32	15	16	7	49
Water Pipit	12	-	-	-	1
Cedar Waxwing	-	5	11	18	8
Starling	410	198	127	199	177
White-eyed Vireo	1	-	2	4	1
Yellow-throated Vireo	7	4	4	14	15
Solitary Vireo	1	2	5	2	-
Red-eyed Vireo	2	3	10	28	7
Philadelphia Vireo	-	-	1	3	6
Warbling Vireo	10	16	13	13	11
Black-and-white Warbler	10	19	38	16	31
Prothonotary Warbler	-	2	3	-	1
Worm-eating Warbler	-	-	1	-	1
Golden-winged Warbler	4	2	10	6	-
Blue-winged Warbler	1	16	20	8	37
Tennessee Warbler	4	1	35	30	16
Orange-crowned Warbler	1	1	3	1	3
Nashville Warbler	11	5	21	9	7
Northern Parula Warbler	-	1	2	2	-
Yellow Warbler	22	59	69	54	107
Magnolia Warbler	2	2	92	37	36
Cape-May Warbler	-	2	14	8	13

Table 3-133 continued

	1976	1977	1978	1979	1980
Black-throated Blue Warbler	-	-	2	3	-
Yellow-rumped Warbler	117	47	54	193	340
Black-throated Green Warbler	8	14	84	12	36
Cerulean Warbler	3	2	7	14	20
Blackburnian Warbler	-	1	31	19	45
Yellow-throated Warbler	-	-	-	-	1
Chestnut-sided Warbler	-	5	56	49	11
Bay-breasted Warbler	-	-	23	23	29
Blackpoll Warbler	-	-	5	13	6
Pine Warbler	-	-	2	-	-
Prairie Warbler	3	2	-	1	1
Palm Warbler	55	42	164	39	136
Ovenbird	7	17	69	35	23
Northern Waterthrush	5	5	30	13	3
Louisiana Waterthrush	3	2	18	8	3
Kentucky Warbler	-	-	1	1	-
Connecticut Warbler	-	-	2	3	2
Mourning Warbler	-	-	3	1	-
Common Yellowthroat	52	92	134	43	105
Yellow-breasted Chat	-	2	4	3	4
Hooded Warbler	3	-	1	2	2
Wilson's Warbler	1	2	14	24	4
Canada Warbler	-	1	6	16	1
American Redstart	1	8	122	134	34
House Sparrow	243	213	113	106	101
Bobolink	108	25	22	24	31
Eastern Meadowlark	59	23	9	15	38
Western Meadowlark	3	-	-	-	2
Red-winged Blackbird	853	457	397	464	756
Orchard Oriole	-	2	-	-	4
Northern Oriole	20	22	48	37	81
Rusty Blackbird	-	-	-	-	4
Brewer's Blackbird	-	-	-	-	2
Common Grackle	508	369	339	531	483
Brown-headed Cowbird	105	132	96	80	189
Scarlet Tanager	1	4	58	32	23
Western Tanager	-	1	-	-	-
Cardinal	123	91	121	81	121
Rose-breasted Grosbeak	32	22	109	68	104
Indigo Bunting	4	10	40	30	12
Dickcissel	7	1	-	-	1
Evening Grosbeak	20	-	-	-	-
Purple Finch	1	1	33	11	2
House Finch	-	-	-	-	2
Pine Siskin	2	-	107	-	-
American Goldfinch	203	164	374	185	373
Rufous-sided Towhee	70	24	78	36	62
Savannah Sparrow	31	7	6	4	3
Vesper Sparrow	2	4	3	4	3
Grasshopper Sparrow	1	-	5	2	2
Dark-eyed Junco	10	-	5	2	-
Tree Sparrow	3	-	-	1	1
Chipping Sparrow	81	58	39	28	64
Clay-colored Sparrow	-	-	-	1	-

Table 3-133 continued

	1976	1977	1978	1979	1980
Field Sparrow	59	54	46	25	50
Harris' Sparrow	1	-	-	-	-
White-crowned Sparrow	79	31	70	33	106
White-throated Sparrow	172	75	70	43	158
Fox Sparrow	-	-	-	-	1
Lincoln's Sparrow	-	1	7	2	1
Swamp Sparrow	34	21	30	13	28
Song Sparrow	108	75	85	66	132

Table 3-134. Breeding bird census data for area which includes eastern two-thirds of Indiana Dunes National Lakeshore except Pinhook Bog (see text for details). From Tweit 1975, 1981.

	28 June 1975	12 June 1976	4 June 1977
Pied-billed Grebe	8	5	2
Great Blue Heron	24	8	6
Green Heron	48	21	25
Little Blue Heron	2	1	1
Great Egret			1
Black-crowned Night Heron	1		
Least Bittern		3	4
American Bittern	1		
Canada Goose		7	7
Mallard	61	23	15
Blue-winged Teal	7	2	2
Green-winged Teal		2	
Wood Duck	25	26	27
Turkey Vulture	25	17	9
Red-tailed Hawk	5	3	1
Red-shouldered Hawk	1		1
Broad-winged Hawk		1	1
Northern Harrier	1		
American Kestrel	6	6	
Bobwhite	41	16	3
Ring-necked Pheasant	14	6	2
Virginia Rail		4	2
Sora			2
Common Gallinule	2	3	1
American Coot	2	6	13
Killdeer	83	27	5
American Woodcock	6	1	2
Common Snipe		3	
Spotted Sandpiper	8	3	4
Solitary Sandpiper			1
White-rumped Sandpiper			1
Herring Gull	8		
Gull sp.		150	
Tern sp.		1	
Rock Dove	17	73	7
Mourning Dove	158	123	28
Yellow-billed Cuckoo	9	6	6
Black-billed Cuckoo	2	2	2
Screech Owl	4	8	
Barred Owl	5	2	
Whip-poor-will	7	5	5
Common Nighthawk	5	34	
Chimney Swift	16	20	22
Ruby-throated Hummingbird	18	13	6
Belted Kingfisher	6	5	4
Common Flicker	62	44	15
Red-bellied Woodpecker	9	7	12
Red-headed Woodpecker	46	31	15

Table 3-134 continued

	1975	1976	1977
Hairy Woodpecker	8	7	9
Downy Woodpecker	40	12	11
Eastern Kingbird	13	15	4
Great-crested Flycatcher	11	17	29
Eastern Phoebe	2		
Acadian Flycatcher		15	13
Alder Flycatcher		1	5
Willow Flycatcher		8	15
Least Flycatcher	1	2	3
Eastern Wood Peewee	31	17	23
Olive-sided Flycatcher			2
Horned Lark		2	
Tree Swallow	49	46	7
Bank Swallow	90	51	27
Rough-winged Swallow	2	5	4
Barn Swallow	77	63	38
Purple Martin	46	57	38
Blue Jay	117	90	32
Common Crow	72	36	10
Black-capped Chickadee	35	12	13
Tufted Titmouse	61	36	19
White-breasted Nuthatch	23	16	5
Brown Creeper		2	
House Wren	112	54	20
Winter Wren		1	
Carolina Wren	3		
Long-billed Marsh Wren	7	15	
Short-billed Marsh Wren	2	4	3
Gray Catbird	94	66	42
Brown Thrasher	48	31	14
American Robin	293	288	50
Wood Thrush	36	38	21
Veery	13	18	20
Eastern Bluebird	10	6	
Blue-gray Gnatcatcher	1	2	4
Cedar Waxwing	33	28	21
Starling	127	197	29
White-eyed Vireo		1	2
Yellow-throated Vireo	7	5	14
Red-eyed Vireo	41	43	30
Warbling Vireo		4	5
Black-and-white Warbler		2	1
Prothonotary Warbler	1		
Worm-eating Warbler		1	
Golden-winged Warbler	1		7
Blue-winged Warbler	7	11	10
Tennessee Warbler			1
Yellow Warbler	29	57	48
Cerulean Warbler	7	8	10
Chestnut-sided Warbler	1	1	
Prairie Warbler	2	3	7
Ovenbird	15	19	11
Kentucky Warbler			1
Louisiana Waterthrush	1	4	
Common Yellowthroat	41	69	62

Table 3-134 continued

	1975	1976	1977
Yellow-breasted Chat	2	6	4
Hooded Warbler	5	3	3
Canada Warbler		2	1
American Redstart	16	10	10
House Sparrow	225	162	5
Bobolink	5	15	5
Eastern Meadowlark	13	22	2
Western Meadowlark		3	
Red-winged Blackbird	295	454	100
Orchard Oriole		2	
Northern Oriole	25	11	11
Common Grackle	410	403	134
Brown-headed Cowbird	172	67	52
Scarlet Tanager	15	17	20
Cardinal	104	92	41
Rose-breasted Grosbeak	35	24	3
Indigo Bunting	43	51	41
Dickcissel	2	10	
American Goldfinch	127	74	47
Rufous-sided Towhee	40	32	41
Savannah Sparrow	1	5	
Vesper Sparrow	1	5	
Chipping Sparrow	44	17	1
Field Sparrow	43	15	25
Fox Sparrow	1	1	
Swamp Sparrow	5	11	9
Song Sparrow	47	84	29

Table 3-135. An annotated list of birds known to nest, or possibly to nest, in the Indiana dunes area.

Common name	Abundance	Habitats
Pied-billed Grebe	common	open water, shores, marshes
Great Blue Heron	common	shores, swamps, woods, marshes
Green Heron	common	shores of ponds and streams, marshes, swamps, thickets
Black-crowned Night Heron	uncommon	shores, marshes, swamps, grasslands, thickets, woods
(There are nesting colonies nearby, but no record of any in the National Lakeshore.)		
Least Bittern	uncommon	marshes
Canada Goose	common	open water, marshes, grasslands
Mallard	common	open water, shores, marshes, grasslands
Blue-winged Teal	common	ponds and streams, marshes, grasslands
Wood Duck	uncommon	ponds and streams, swamps, woods
Turkey Vulture	common	swamps, grasslands, thickets, woods
(They probably breed here though there are no records.)		
Cooper's Hawk	uncommon	grasslands, thickets, woods, farms
(They probably breed here though there are no records.)		
Red-tailed Hawk	common	grasslands, thickets, woods, farms
Red-shouldered Hawk	rare	marshes, swamps, grasslands, thickets, woods, farms
Broad-winged Hawk	rare	grasslands, thickets, woods, farms
American Kestrel	uncommon	swamps, grasslands, thickets, woods, farms, suburbs
Common Bobwhite	common	grasslands, thickets, farms
Ring-necked Pheasant	uncommon	swamps, grasslands, thickets, woods, farms
King Rail	rare	marshes
Virginia Rail	uncommon	marshes
Sora	common	marshes
Common Gallinule	common	ponds and streams, marshes
American Coot	abundant	ponds and streams, marshes

Table 3-135 continued

Common name	Abundance	Habitats
Killdeer	common	shores, grasslands, farms, suburbs
American Woodcock	common	shores of ponds and streams, marshes, swamps, grasslands, thickets, woods, farms
Common Snipe	rare	shores, marshes, grasslands (There are recent summer records; possibly it breeds here.)
Spotted Sandpiper	common	shores, grasslands, farms
Solitary Sandpiper	uncommon	(There are summer records; possibly it breeds here.)
Black Tern	common	shores, open water
Rock Dove	abundant	grasslands, farms, suburbs
Mourning Dove	abundant	shores, grasslands, thickets, woods, farms
Yellow-billed Cuckoo	common	swamps, grasslands, thickets, woods, farms, suburbs
Black-billed Cuckoo	uncommon	swamps, grasslands, thickets, woods
Screech Owl	uncommon	swamps, grasslands, thickets, woods, farms, suburbs
Great Horned Owl	uncommon	swamps, thickets, woods
Barred Owl	uncommon	swamps, woods
Whip-poor-will	uncommon	swamps, thickets, woods, farms
Common Nighthawk	uncommon	grasslands, thickets, woods, farms, suburbs
Chimney Swift	common	throughout
Ruby-throated Hummingbird	uncommon	thickets, woods, farms, suburbs
Belted Kingfisher	common	shores, marshes, grasslands, farms
Common Flicker	common	swamps, grasslands, thickets, woods, farms, suburbs
Red-bellied Woodpecker	uncommon	woods, farms
Red-headed Woodpecker	common	swamps, grasslands, thickets, woods, farms, suburbs
Hairy Woodpecker	uncommon	swamps, thickets, woods, farms
Downy Woodpecker	abundant	swamps, thickets, woods, farms, suburbs
Eastern Kingbird	common	shores of ponds and streams, marshes, swamps, grasslands, thickets, farms

Table 3-135 continued

Common name	Abundance	Habitats
Great Crested Flycatcher	common	swamps, thickets, woods, farms, suburbs
Eastern Phoebe	rare	shores of ponds and streams, swamps, grasslands, thickets, woods, farms, suburbs
Acadian Flycatcher	common	thickets, woods, farms
Willow Flycatcher	common	shores of ponds and streams, marshes
Least Flycatcher	uncommon	shores of ponds and streams, thickets
Eastern Wood Peewee	common	swamps, thickets, woods, farms, suburbs
Horned Lark	common	shores of Lake M., grasslands, farms
Tree Swallow	common	throughout except suburbs
Bank Swallow	common	throughout except suburbs
Rough-winged Swallow	uncommon	throughout except suburbs
(They probably breed here though there are no records.)		
Barn Swallow	common	throughout
Purple Martin	common	open water, shores, marshes, grasslands, farms, suburbs
Blue Jay	abundant	swamps, grasslands, thickets, woods, farms, suburbs
Common Crow	common	throughout except Lake Michigan
Black-capped Chickadee	uncommon	swamps, grasslands, thickets, woods, farms, suburbs
Tufted Titmouse	common	swamps, grasslands, thickets, woods, farms, suburbs
White-breasted Nuthatch	uncommon	swamps, grasslands, thickets, woods, farms, suburbs
House Wren	common	swamps, grasslands, thickets, woods, farms, suburbs
Carolina Wren	rare	shores, marshes, swamps, grasslands, thickets, woods, farms
(They nested here in mid 70s but have not been recorded since recent hard winters.)		
Marsh Wren	common	shores, marshes
Sedge Wren	uncommon	shores, marshes

Table 3-135 continued

Common name	Abundance	Habitats
Gray Catbird	common	shores, marshes, swamps, grasslands, thickets, woods, farms, suburbs
Brown Thrasher	common	grasslands, thickets, woods, farms, suburbs
American Robin	abundant	shores of ponds and streams, marshes, swamps, grasslands, thickets, woods, farms, suburbs
Wood Thrush	common	swamps, thickets, woods, farms, suburbs
Veery	common	swamps, thickets, woods, farms
Eastern Bluebird	rare	shores of ponds and streams, grasslands, thickets, woods, farms
Blue-gray Gnatcatcher	uncommon	thickets, farms
Cedar Waxwing	common	thickets, woods, farms, suburbs
Starling	abundant	shores, grasslands, thickets, farms, suburbs
White-eyed Vireo	rare	thickets, woods
Yellow-throated Vireo	common	thickets, woods, farms, suburbs
Red-eyed Vireo	abundant	shores of ponds and streams, marshes, swamps, grasslands, thickets, woods, farms, suburbs
Warbling Vireo	common	shores of ponds and streams, marshes, swamps, grasslands, thickets, woods, farms, suburbs
Black-and-white Warbler	uncommon	shores of ponds and streams, swamps, grasslands, thickets, woods, farms, suburbs
Prothonotary Warbler	rare	shores of ponds and streams, marshes, thickets, woods
Golden-winged Warbler	uncommon	shores of ponds and streams, swamps, thickets, woods
Blue-winged Warbler	common	shores of ponds and streams, swamps, thickets, woods
(Hybrids of this and the preceding species have been regularly reported in the Indiana Dunes State Park near Tremont.)		
Northern Parula Warbler	rare	shores of ponds and streams, thickets, woods, farms
(There is some possibility that this species is breeding here.)		

Table 3-135 continued

Common name	Abundance	Habitats
Yellow Warbler	common	shores of ponds and streams, marshes, swamps, grasslands, thickets, woods, farms, suburbs
Cerulean Warbler	common	swamps, woods
Chestnut-sided Warbler	rare	shores of ponds and streams, marshes, swamps, grasslands, thickets, woods, farms, suburbs
Prairie Warbler	uncommon	shores of ponds and streams, thickets, woods, farms
Ovenbird	common	shores of ponds and streams, swamps, thickets, woods, farms, suburbs
Louisiana Waterthrush	uncommon	shores of ponds and streams, swamps, thickets, woods, farms, suburbs
Mourning Warbler	rare	shores, marshes, swamps, grasslands, thickets, woods, farms, suburbs
Common Yellowthroat	abundant	shores, marshes, swamps, thickets, grasslands, woods, farms, suburbs
Yellow-breasted Chat	uncommon	shores of ponds and streams, marshes, swamps, grasslands, thickets
Hooded Warbler	rare	shores of ponds and streams, swamps, thickets, woods
Canada Warbler	rare	shores of ponds and streams, marshes, swamps, grasslands, thickets, woods, farms, suburbs
American Redstart	common	shores, marshes, swamps, grasslands, thickets, woods, farms, suburbs
House Sparrow	abundant	shores, grasslands, thickets, farms, suburbs
Bobolink	common	marshes, grasslands, farms
Eastern Meadowlark	common	marshes, grasslands, thickets, farms
Western Meadowlark	rare	marshes, grasslands, thickets, farms (There are records of nesting within a few miles of the National Lakeshore; possibly it breeds here.)
Red-winged Blackbird	abundant	shores, marshes, swamps, grasslands, thickets, farms
Northern Oriole	common	grasslands, thickets, woods, farms
Common Grackle	abundant	throughout

Table 3-135

Common name	Abundance	Habitats
Brown-headed Cowbird	common	throughout except Lake Michigan
Scarlet Tanager	common	shores of ponds and streams, swamps, thickets, woods, farms
Cardinal	common	throughout except Lake Michigan
Rose-breasted Grosbeak	common	shores of ponds and streams, thickets, woods, farms, suburbs
Indigo Bunting	abundant	throughout except Lake Michigan
American Goldfinch	common	throughout except Lake Michigan
Rufous-sided Towhee	common	thickets, woods, farms, suburbs
Savannah Sparrow	uncommon	marshes, grasslands, thickets
Vesper Sparrow	uncommon	grasslands, thickets, farms
Chipping Sparrow	common	shores of ponds and streams, grasslands, thickets, woods, farms, suburbs
Field Sparrow	common	grasslands, thickets, farms
Swamp Sparrow	common	shores of ponds and streams, marshes
Song Sparrow	abundant	throughout except Lake Michigan

h) thickets -- shrubby growth at edge of woods, in abandoned fields, of hedgerows;
i) woods;
j) farms -- combination of clearings and trees as on farms, in parks, cemeteries, orchards;
k) suburbs -- areas with concentrations of houses and other buildings, including urban area.

The habitats indicated in this tabulation from those in which this species is most regularly seen; this may or may not be the place where nesting occurs. Moreover, the abundance indicated is that during the summer months, the breeding season.

In compiling this list, which includes not only those species which are known to breed in the dunes area through nesting records, but also those which probably or possibly nest here, the author of this chapter consulted with two individuals in particular. One was Dr. Russell Mumford who was long the Indiana state editor of Audubon Field Notes and is thoroughly familiar with the past records of the dunes region. The other was Dr. Kenneth Brock who has directed the Big Day counts and the recent (since 1977) Christmas counts in the Indiana Dunes National Lakeshore and who will in future years (beginning 1981) direct the breeding bird censuses there. The former's assistance was particularly valuable with respect to past records and the latter's with respect to recent records. I gratefully acknowledge their contributions. The inclusion of birds which probably and possibly breed in the dunes area indicates where special efforts to find nests could be profitably expended in future studies.

Mammals

The distribution and habitats of the mammals of Indiana have been thoroughly reviewed recently by Mumford (1969). Dr. Mumford also graciously consulted with the author of this chapter personally concerning details and records for the dunes area. This assistance is acknowledged with gratitute. Information relative to the mammals of the Indiana dunes area is presented in Table 3-136.

In Table 3-137 are given the numbers of mammals obtained by the Texas Instruments team during six years of study in the eight sample locations indicated. Note that they have collected and observed 24 of the 43 species which are known or can be expected to occur in the Indiana dunes area; a 25th species, the fox (probably the red fox rather than the gray fox) was identified as being present by tracks and/or scat.

Table 3-136. An annotated list of mammals known to occur, or possibly to occur, in the Indiana dunes area.

Common name	Abundance	Habitats
Opossum	uncommon	woods, thickets, farms, suburbs
Masked Shrew	uncommon	moist habitats with a fairly dense ground cover, including foredunes, grasslands, marshes, swamps
Short-tailed Shrew	common	grasslands (including foredunes), marsh borders, woods, thickets
Least Shrew	rare	weedy or brushy fields
Eastern Mole	common	throughout
Little Brown Myotis	common	flies along borders of woods and streams; breeding colonies in buildings; hibernates in caves
Keen's Myotis	uncommon	flies over streams and ponds of farms; frequents caves where it also hibernates
Indiana Myotis	rare	flies near woods and over water; hibernates in caves
Silver-haired Bat	uncommon	flies near woods and over water; hibernates in caves
Big Brown Bat	common	throughout; uses buildings as roosts at all seasons
Evening Bat	rare	flies near woods and over water
Red Bat	common	throughout, but prefers woods or thickets; roosts in trees and shrubs, often in suburbs
Hoary Bat	rare	flies near woods and over water; roosts in trees
Eastern Cottontail	common	habitats with a dense ground cover, including foredunes, grasslands, thickets, small woodlots, suburbs
Gray Squirrel	common	woods, suburbs (This species was extirpated from the northern third of the state but has been reintroduced in certain localities; it is now common in Valparaiso, Chesterton, and certain parts of the National Lakeshore.)

Table 3-136 continued

Common name	Abundance	Habitats
Fox Squirrel	common	open woods, thickets, farms
Red Squirrel	common	woods, farms, suburbs
Woodchuck	abundant	woods, farms, thickets, railroad embankments
Thirteen-lined Ground Squirrel	common	pastures, road borders, dunes, weedy or cultivated fields
Franklin's Ground Squirrel	uncommon	roadsides, open fields or pastures, dunes, thickets
Eastern Chipmunk	abundant	open woods, thickets, suburbs
Southern Flying Squirrel	common	woods, suburbs
Beaver	uncommon	ponds, streams, marshes, drainage ditches
		(This species has been introduced into Indiana following former extirpation; it has caused high water problems on the road leading into Dune Acres.)
Deer Mouse	abundant	foredunes, grasslands, thickets, old fields
White-footed Mouse	abundant	foredunes, dry and wet woods, thickets, marsh borders
Lemming Mouse	uncommon	areas with lush ground cover of grass, bogs
Muskrat	common	marshes, ponds and streams
Pine Vole	uncommon	woods, thickets, grasslands
Meadow Vole	abundant	moist areas with dense grass or weed cover, including foredunes, marshes, and shores of ponds and streams
Prairie Vole	uncommon	relatively dry fields with a cover of grasses or weeds
Norway Rat	common	farms, suburbs, ditches
House Mouse	common	farms, suburbs, ditches, grain field, meadows
Meadow Jumping Mouse	uncommon	moist areas with dense cover of weeds and shrubs, including foredunes, marsh borders
Coyote	rare	areas with dense growth of oak saplings, thickets

Table 3-136 continued

Common name	Abundance	Habitats
Red Fox	common	old fields, farms, thickets
Gray Fox	rare	thickets, woods
Raccoon	common	woods near ponds and streams, grasslands, farms
Least Weasel	uncommon	open, cultivated land
Long-tailed Weasel	uncommon	woods, near ponds and streams, farms
Mink	uncommon	borders of ponds, streams, and marshes whether wooded or non-wooded
Badger		old fields, especially in morainal area
(There are specimen records for St. Joseph, Starke, and Pulaski counties, sight records for Lake, Porter, and LaPorte counties; it may well be found in the National Lakeshore.)		
Striped Skunk	uncommon	thickets, woods, grasslands
(Forages on beach of Lake Michigan.)		
White-tailed Deer	common	woods, thickets, swamps, farms
(This species has been introduced into Indiana following former extirpation; its tracks are regularly seen in the National Lakeshore.)		

Table 3-137. Counts of mammals collected and observed in six years by Ecological Services of Texas Instruments Incorporated at eight sample locations near Bailly generating station. From Texas Instruments (1975, 1976, 1977, 1978, 1979, 1980).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Opossum	x	x	x	x	x	1		
Masked Shrew					1			1
Short-tailed Shrew	4		6	11		5		56
Eastern Mole	x	x	1	1	x	x		x
Little Brown Myotis				1				
Eastern Cottontail	4	2	2	9	1	4	2	24
Gray Squirrel			1	16		6		
Fox Squirrel			9	53	1	5		
Red Squirrel			7	46	1	8		
Woodchuck			x	4	2	1	2	
13-lined Ground Squirrel					2			1
Eastern Chipmunk		13	18	120		13		
Southern Flying Squirrel				3				
White-footed Mouse	66		75	78		111		10
Muskrat				4	13		53	
Pine Vole				2				
Meadow Vole								
Meadow Jumping Mouse	4							23
House Mouse	5							
Red/Gray Fox	x	x	x	x	x	x		
Raccoon	1	x	1	2	2	x	1	x
Least Weasel	1			1				
Mink					2			
Striped Skunk		1	1	x		x		
White-tailed Deer	x	1	9	3	3	4	x	x

x = tracks or other signs
(1) young foredune
(2) stable foredune
(3) black oak forest
(4) black oak/swamp forest
(5) Cowles marsh
(6) red maple swamp forest
(7) pond #2
(8) transmission corridor

Bibilography

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